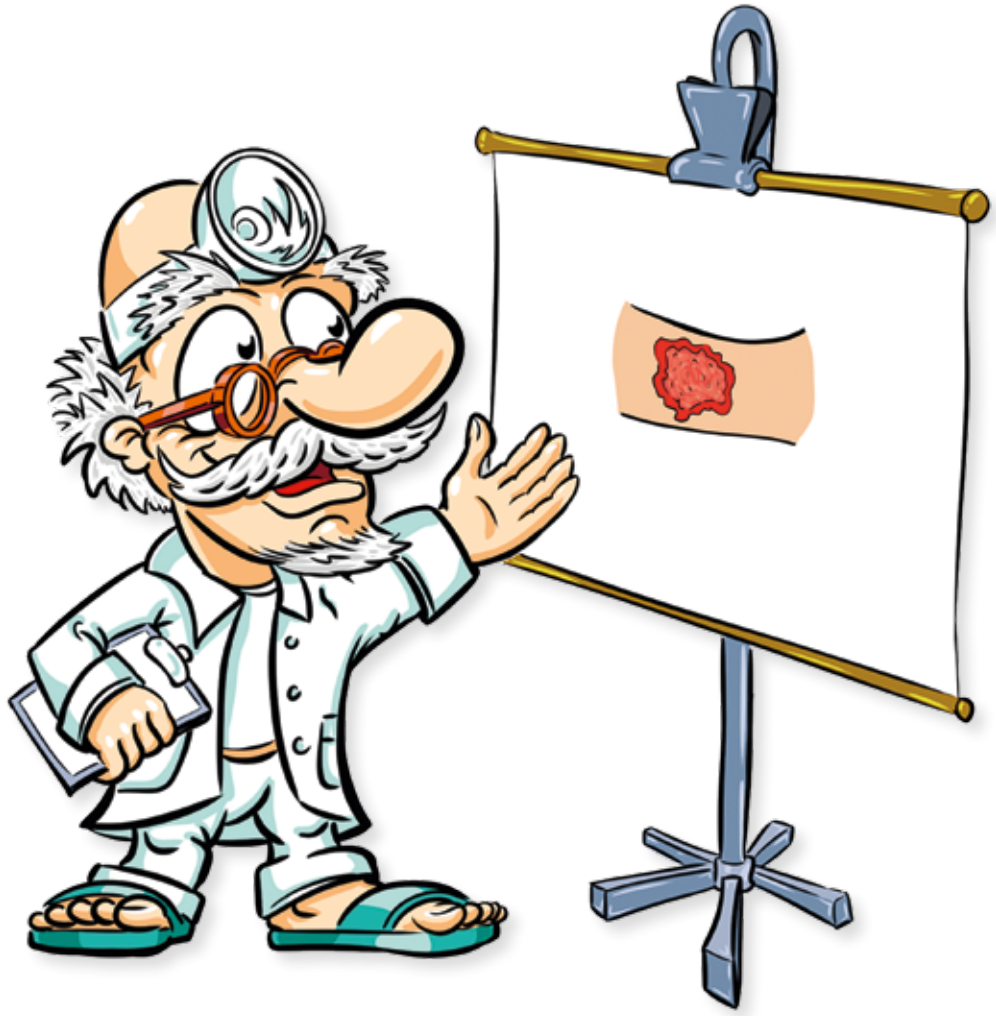
Dr. Gück's® Compendium

Wound Cleaning - Wound Healing - Prevention & Recurrence Prophylaxis



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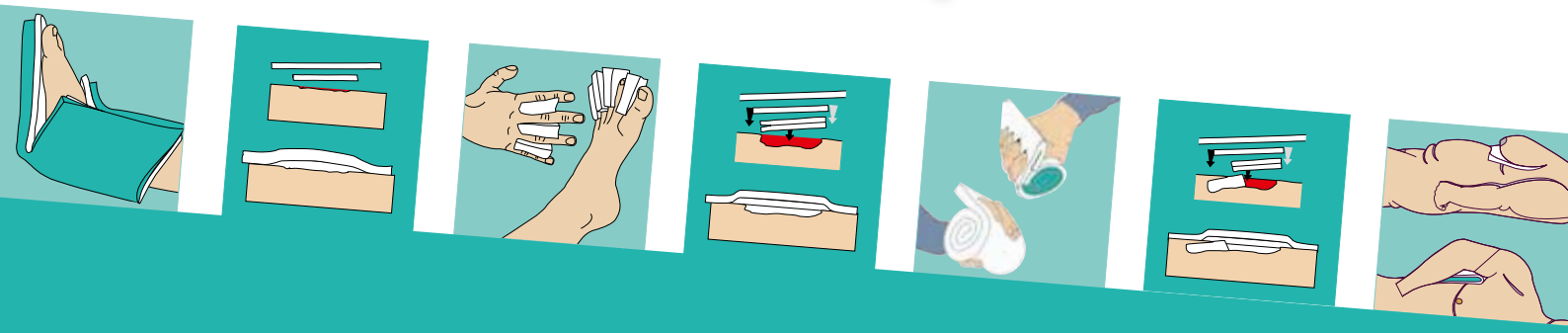

Anatomy and physiology of the skin
Wound healing
Debridement
Modern wound treatment
Prevention + recurrence prophylaxis

with many examples of application

Important note: All information, especially on the application, has been carefully checked and corresponds to our current state of knowledge at the time this publication was published. Nevertheless, every user is advised to check the instruction leaflet of the preparations carefully before application. Any dosage or application is at the user's own risk.

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Chapter 1: Anatomy and Physiology of the Skin

1.1 Cell Structure

The human body consists of over 200 different types of cells, spread over 12 organs and over 50 different tissues. A fully grown human body has over 1,000 trillion cells, which share a common subcellular structure, aside from obvious structural and functional differences.

The typical cell, as described below, is only one model, necessary for learning and understanding the main elements of cell anatomy and cell physiology. All eukaryotic cells, i.e. cells that have a nucleus, have the same common structure:

- Cell membrane
- Cell plasma, consisting of the cell nucleus, cell protoplasm, endoplasmic reticulum, golgi apparatus, mitochondria, lysosomes and peroxisomes, cytoskeleton

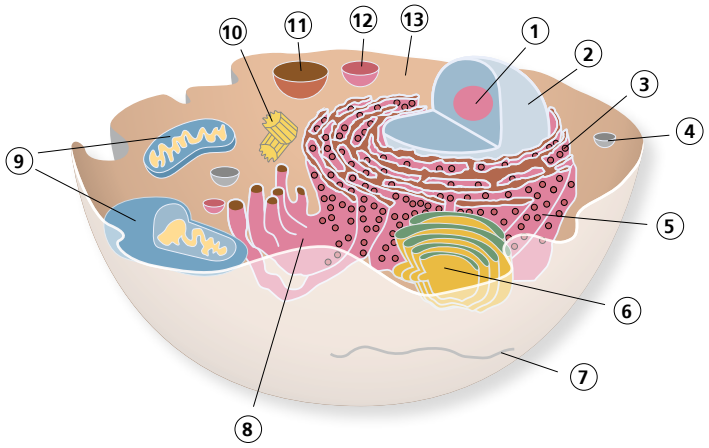

Fig. 1.1.1:
Cell with
1. Nucleolus
2. Nucleus
3. Ribosomes
4. Vesicle
5. Rough endoplasmic reticulum
6. Golgi apparatus
7. Microtubules
8. Smooth endoplasmic reticulum
9. Mitochondria
10. Centrioles
11. Lysosome
12. Peroxisome
13. Cytoplasm

The **cell membrane** (membrana cellularis) with a thickness of about 0.0075 µm is a tessellated lipoprotein membrane. Its main component is a lipid bilayer that mainly contains phospholipids, glycolipids and cholesterol. Each cell identifies itself to the outside using its peripheral proteins, which are known as surface antigen. The proportion of membrane lipids and proteins varies depending on the cell and tissue. For example, the membrane of a liver cell contains about 50% lipids and 50% proteins, whereas the membrane of a Schwann cell contains 72% lipids and only 28% proteins.

In addition, short-chain carbohydrate compounds, some of which are branched like trees, are often attached to the proteins and lipids for marking on the outside of the cell membrane; these are known as glycoproteins or glycolipids. Among other things, the outwardly projecting structures of the cell membrane have receptor, transport and stabilising functions. These glycoproteins and glycolipids also form the glycocalyx, which plays a major role in intercellular adhesion, antigen recognition and to defend against various external attacks. Furthermore, the cell membrane absorbs bound molecules by means of protein-lipid interactions through the invagination and constriction of cell membrane sections (phagocytosis). Liquid or particles dissolved in liquid are absorbed by pinocytosis.

The **nucleus** is the largest of the cytoplasmic organelles with a diameter of 5 to 16 µm, consisting of the cell membrane, nucleus and cell chromatin. The cell nucleus is the main feature for differentiating between eukaryotes (living things with a demarcated nucleus) and prokaryotes (living things without a demarcated nucleus, i.e. bacteria and archaea). It contains the majority of the genetic material of the eukaryotic cells in the form of multiple chromosomes.

The cell nucleus membrane consists of two biological membranes, the inner and outer nuclear membrane, which enclose what is known as the perinuclear cisterna. The total thickness of the nuclear envelope is about 35 nm. The outer nuclear membrane flows fluently into the rough endoplasmic reticulum and, like this, has ribosomes on its surface. The inner nuclear membrane is adjacent to the nuclear lamina (lamina fibrosa nuclei), which is made up of a group of intermediate filaments called lamins, which supports the nucleus and separates the inner membrane from the chromatin of the nucleus. The human diploid cell contains 23 pairs of chromosomes with over 100,000 genes. The nucleolus is the largest structure in the cell nucleus. The ribosomes are synthesised therein. Through the nuclear pores contained in the nuclear envelope, which cover approximately 25% of the surface, active substance exchange (e.g. rRNA or mRNA) occurs between the nucleus and the cytoplasm. The fluid in the nucleus is also known as the caryoplasm.

The **cytosol** is the name given to the liquid components of the cytoplasm of the eukaryotic and prokaryotic cells. It consists of about 70% water, 20% proteins and 10% of ions, vitamins, metabolic products. Part of the protein biosynthesis, the translation, takes place in the cytosol. In addition, glycolysis, many steps of protein degradation

and many reactions of intermediary cell metabolism occur here. This includes, for example, the synthesis and breakdown of nucleotides or amino acids. The cytosol is crisscrossed in eukaryotes by a network of thread-like structures (filaments) such as actin filaments, intermediate filaments and microtubules, which form the cell skeleton (cytoskeleton) in its entirety.

The **endoplasmic reticulum** (ER) is composed of an extensive membrane network of tubes, blisters and cisternae, which are surrounded by the ER membrane. The ER membrane merges directly into the nuclear envelope of the nucleus. The ER lumen is connected to the intermembrane space of the nuclear envelope, the perinuclear space. There are two types of endoplasmic reticulum:

- The membrane surface of the **rough endoplasmic reticulum** is covered with ribosomes. It is responsible for most of the synthesis of cell proteins.
- The **smooth endoplasmic reticulum** is responsible for most of lipid and polysaccharide synthesis.

The structure of the ER is dynamic and subject to constant reorganisation. This includes the lengthening and retraction of membrane tubules, their branching, merging or splitting. This ER motility depends on the cytoskeleton.

The **golgi apparatus** is a formation of cavities near the vicinity of the nucleus and the rough endoplasmic reticulum. Its main task is the formation and storage of secretory vesicles (extracellular matrix, transmitters/hormones), the synthesis and modification of plasma membrane elements and the formation of lysosomal proteins (primary lysosome).

Mitochondria are cellular organelles that are spherical or cylindrical in appearance and play an important role in oxidative processes, which guarantee cellular respiration and energy supply. A cell has about 1,700 mitochondria, depending on the energy requirements of the cell. The following processes take place in the mitochondria: aerobic glycolysis, citric acid cycle and phosphorylation, through which hydrocarbons are converted into carbon dioxide, water and energy.

Lysosomes are spherical vesicles, the membrane of which contains 50 different enzymes (proteases, nucleases, lipases, phosphoric acid, etc.). They play an essential role in cell digestion and defence. They are also involved in programmed cell death, apoptosis, and the decomposition of foreign material in the cell.

Peroxisomes are spherical organelles that are surrounded by a cell membrane. They are important for neutralising hydrogen peroxide, which occurs as a result of a variety of metabolic processes.

The **cytoskeleton** or cell skeleton is a network made up of proteins in the cytoplasm of eukaryotic cells. It consists of thin, thread-like cell structures (filaments) that can be dynamically built up and degraded. It is responsible for mechanically stabilising the cell and its external shape, for active movements of the cell as a whole, and for movements and transportation within the cell.
There are three different classes of cytoskeletal filaments in the eukaryotic cell, which are each formed from different proteins or protein classes, have specific accompanying proteins and participate in different ways in the duties of the cytoskeleton:

- **Microtubules** are the largest elements of the cytoskeleton. These hollow cylinders with a diameter of 25 nm are made up of the protein, tubulin.
- **Actin filaments** (or microfilaments) are fibres with a 7 nm diameter, which consist of actin. Predominantly in reticular arrangements beneath the plasma membrane and in membrane protrusions, they stabilise the outer form of the cell, keep membrane-bound proteins in their place and infiltrate certain cell junctions.
- The term **intermediate filaments** summarises a series of protein filaments, which all have very similar properties. Their diameter is about 10 nm (8 to 11 nm), and they are brilliant at absorbing mechanical tensile forces because they are significantly more stable than microtubules and actin filaments.

Cell junctions or cell contacts describe the direct points of contact of cells in tissues. Temporary or permanent cell contacts are formed by all multicellular living beings. The cell contacts are essentially formed by proteins (adhesion molecules), which protrude from the cell surfaces and, at the same time, form a cytoplasmic plaque as intracellular anchor proteins. Their task is to hold the tissue together and to facilitate inter-cell communication. Many of the cell adhesion molecules are transmembrane proteins that protrude from the inside and outside of the cell membrane. They can forward signals from the outside, e.g. from other cells into the interior or pass on cell signals to the adjacent cells. Cell adhesion molecules provide contacts between cells and also between cells and the extracellular matrix. The connexins and innexins, which are the channel-forming transmembrane proteins of gap junctions, are special features. The cell contact generates cell contact inhibition from a certain cell density.

1.2 Morphology and Physiology of the Skin

The skin (Greek ***δέρμα***, Latin *cutis*) is the largest, heaviest and most complex organ in the human body. The skin surface area of an adult is on average between 1.5 and 2.0 m^2, weighing around 10 kg (6.5 to 7% of the body's weight).
Its area can easily be calculated using the Mosteller formula:

$$\text{Body surface in } m^2 = \sqrt{\frac{\text{Height in cm} \times \text{body weight in kg}}{3600}}$$

The thickness of the skin varies depending on the body region from 0.6 mm (eyelid) to 5-6 mm (back, buttocks). As well as its special skin structures, the skin also has a rich vascular, nervous and lymphatic network. The skin's job is protection, regulation, information exchange, synthesis and secretory function. The outer skin is divided into three main layers: epidermis (cuticle), dermis (true skin) and subcutis (hypoderm). The epidermis and dermis together are known as the cutis. In addition, there are other histological layers in the skin, the skin appendages: hair, nails, and sweat and sebum glands.

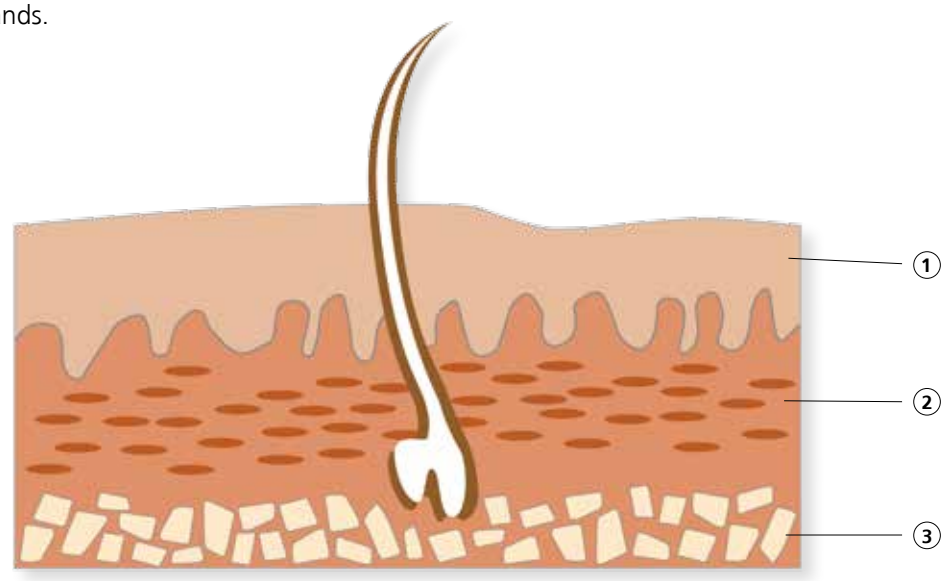

Fig. 1.2.1:
Skin layers:
1) Epidermis
2) Dermis
3) Subcutis

1.2.1 Epidermis

The epidermis is the outermost layer of the skin and is an epithelial tissue (multilayer keratinised squamous epithelium). On the palms and the soles of the feet, the horny layer is up to several millimetres thick.
There are five different epidermis layers:

Stratum basale (basal cell layer)
The basal cell layer is in close contact with the basal membrane, through which it is connected with the underlying dermis. It consists of one or two layers of cubic cells with high mitotic activity. The keratinocytes of the stratum basale have large, oval nuclei. After the division, some of the daughter cells migrate piece by piece to the surface (see Fig. 1.2.2), while the others begin to divide again. The stratum basale houses Merkel cells, special sensory cells for tactile stimuli (see page 13) and melanocytes, which are pigment-forming cells (see page 10).
Demarcation with the underlying dermis is made by a basal membrane. This trilamellar membrane acts as a filter barrier for molecules that are larger 40 kD. However, inflammatory cells, most bacteria and neoplastic cells are able to penetrate this barrier due to complex enzymatic mechanisms. The basal membrane is made up (from top to bottom) from lamina rara (lamina lucida), lamina densa and lamina fibroreticularis.

Stratum spinosum (spinous layer)
The cells of the stratum spinosum are polyhedral, i.e. multi-faceted, and connected to desmosomes by cytoplasmic extensions. This is where keratinisation begins, i.e. the cells become flat, the metabolic activity increasingly reduces and the nucleus shrinks. The defence cells of the lymphatic system, the Langerhans cells, are located in the stratum spinosum (see page 11).
Together, the stratum basale and stratum spinosum are called the stratum germinativum (germ layer).

Stratum granulosum (granule layer)
In the stratum granulosum, the keratinocytes become flatter and flatter and the cytoplasm contains increasing amounts of keratin granulomas and other structural proteins (e.g. filaggrin).

The **stratum lucidum (clear layer)** consists of one to two cell layers of keratinocytes without nuclei and are only found on the palms and soles

The **stratum corneum (horny layer)** is the outermost layer of the epidermis. Depending on the body region, it consists of 12 to 200 layers of corneocytes (i.e. fully cornified keratinocytes). Using fats, the horny layer forms a water-repellent protective layer between the corneocytes.

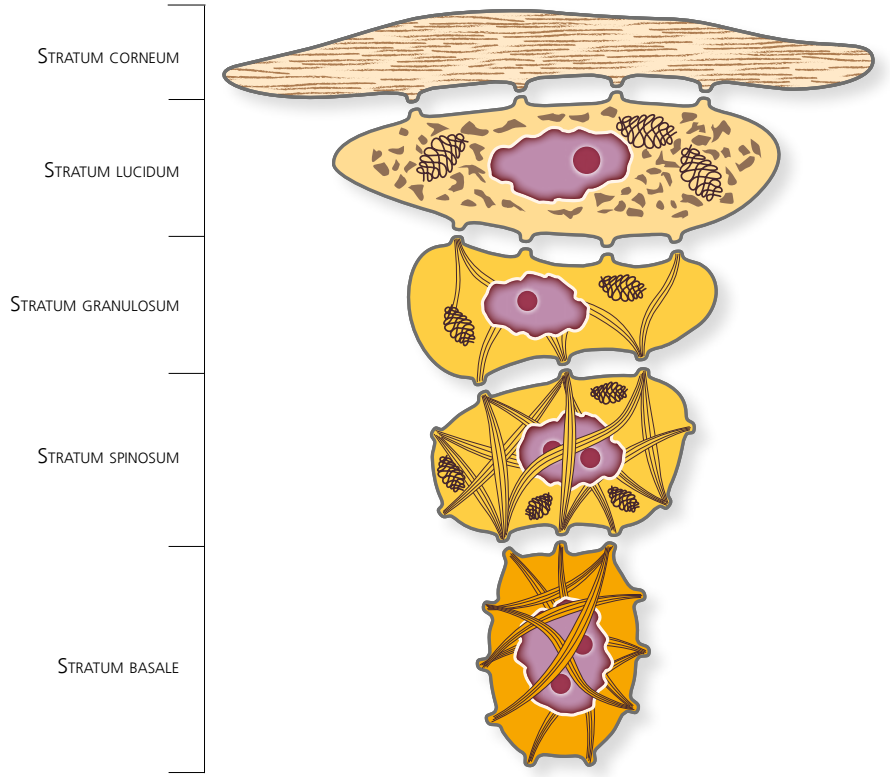

Fig. 1.2.2:
Cornification process:
a) The keratinocytes are formed in the stem cells of the basal membrane
b) The keratin filaments begin to form a three-dimensional network
c) The keratohyalin granules begin to strengthen the keratin network
d) The keratohyalin granules separate lipids out (eleidin)
e) The cornification process is completed in the horny layer and the intercellular adhesion is now at its greatest.
The entire keratinisation process takes 27 days.
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The epidermal cell population is made up from the following elements: keratinocytes, melanocytes, Langerhans cells, Merkel cells, dendritic cells.

Keratinocytes have an ectodermal origin and, with over 90%, they are the predominant cell type in the epidermis. They synthesise a special protein called keratin and become differentiated during keratinisation as they migrate from the stratum basale, the lowest layer of the epidermis, to the stratum corneum. From a biochemical point of view, there are two types of keratin: „soft" keratin in epidermal cells and "hard" keratin in hair and nails. The time between differentiation in the stratum basale and exfoliation as a corneocyte in the stratum disjunctum is about one month. During this differentiation, the keratinocyte changes its shape and geometric alignment. Keratinocytes develop in the stratum basale from epidermal stem cells and have a cylindrical shape. The conversion of cells to increase in volume and change shape in width begins in the stratum spinosum. In the further course, keratohyalin granules are formed in the stratum granulosum and further transformation processes occur. Cells flatten, the nucleus is lost, fluid loss results in shrinkage and finally keratinisation occurs. Finally, no more keratinocytes can be detected in the stratum corneum. Keratinocytes become corneocytes.

Melanocytes (pigment cells), like keratinocytes, have an ectodermal origin and make up about 10% of the epidermal cells. They synthesise melanin and release it to the surrounding keratinocytes, in the form of melanosomes. Melanin provides important skin protection against ultraviolet radiation. Melanin-producing cells form what is known as a melanocyte unit with the surrounding keratinocytes.
Skin colour is not due to an increase in melanocytes. It's actually due to the fact that the melanosomes remain in the keratinocytes for a longer period of time. The melanocytes are located in the basal layer (stratum basale), next to the basal membrane and are connected with this using hemidesmosomes. Melanocytes occur in relatively low numbers and their cytoplasm branches (dendrites) connect them loosely with about 5-8 keratinocytes. Melanocytes are metabolically active and have a number of mitochondria, a pronounced rough endoplasmic reticulum and a large Golgi apparatus. Melanocytes are also found in the choroid and iris of the eye, in the oral mucosa and in other places.

The different skin colours depend on the amount of melanin produced, rather than the number of melanocytes. The production of melanin pigment is influenced by endocrine factors (e.g. the pituitary-thyroidal hypersecretion increases melanin production, the corticoid-suprarenal reduces it), as well as metabolic factors, pharmacological factors and pathological factors. From a biochemical point of view, there are two types of melanin: eumelanin and pheomelanin.

Langerhans cells are mainly found in the stratum spinosum and in mucous membranes. Humans have around 10^9 epidermal Langerhans cells. Langerhans cells are made from monocytes, which are similar in morphology and function to macrophages, but are still inactive dendritic cells. Both the physiology and the role of Langerhans cells is not completely understood, although it has been known for 25 years that they have a large proportion of skin immune responses due to activation of T lymphocytes. The tasks of the Langerhans cells include phagocytosis, presentation and transport of exogenous and endogenous antigens, initiation of the immune response of T lymphocytes, initiation of the immunological feedback between T lymphocytes and B lymphocytes, controlling the secondary immune response of T lymphocytes, a proportion of cutaneous immune surveillance, initiation of immune deficiencies against some specific antigens, part of the rejection of cutaneous allografts.

Merkel cells or Merkel tactile corpuscles are special sensory cells in the stratum basale that act as pressure receptors. They are located individually (in hairless skin) or in groups (in hairy skin) between the basal cells. The complex of Merkel cells and nerve endings is known as Merkel's disc. The cytoplasm of Merkel cells contains granules containing neuropeptides. Merkel cells are among the mechanoreceptors of tactile perception and function as mechanical receptors for pressure sensitivity. In addition, they regulate and control the epidermal structure by inhibiting or stimulating the apoptosis process (e.g. overproduction of keratinocytes in areas of maximum permanent or temporary mechanical stress).

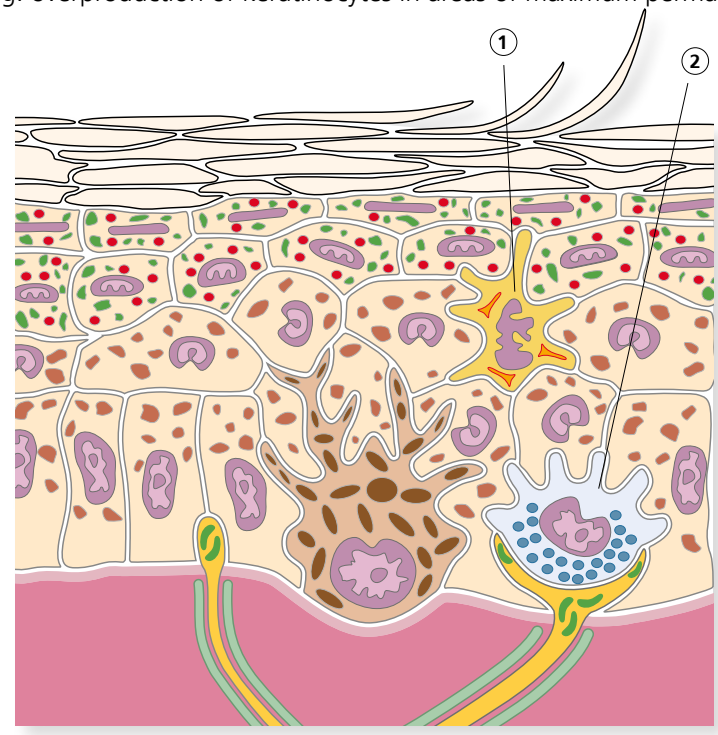


Fig. 1.2.3:
Merkel and Langerhans cells at epidermal level
1) Langerhans cell
2) Merkel cell

1.2.2 Dermis

The middle of the three skin layers works to anchor and nourish the vascular-free epidermis. Leather can be produced if this skin layer is tanned, which is why it is known as "Lederhaut" or "leather skin" in German.
The dermis consists of two layers of skin, the stratum papillare and the stratum reticulare.

Stratum papillare (papillary layer)

The dermo-epidermal transition zone between the epidermis and dermis is wavy to cone-shaped and has lots of capillary vessels. Due to the many invaginations of the stratum papillare in the bottom of the epidermis, a large surface area is formed, consequently producing a firm mechanical connection between the two skin layers. Nutrients are transported easily to the epidermis as a result.
Most sensory cells of the skin are located in stratum papillare. The intercellular spaces (interstices) are filled with a jelly-like liquid, which is drained through the lymphatic system that begins here. Lots of cells can move more or less freely in this tissue, for example, macrophages, lymphocytes, plasma cells, mast cells, granulocytes and monocytes, as well as fibroblasts.

Stratum reticulare (reticular layer)
The stratum reticulare is the thicker of the two dermal layers and provides the basic structure for the skin's resistance. In the reticular layer, there is a densely interwoven connective tissue with type I collagen fibres and elastic fibres. The amount of fluid in this layer determines the skin's firmness of the skin.

The epidermis and dermis are anchored to one another and communicate extensively due to the vertical structures of the skin appendages. The dermis consists of cellular components, fibril components, base substance, vascular components (blood and lymph vessels) and nerve components.

The dermis houses a permanently existing cell population with a mesenchymal origin, consisting of fibroblasts, histiocytes, mast cells, macrophages and dendritic cells. In addition, it has cells, which are only present under certain conditions, for example, leukocytes, lymphocytes, etc.

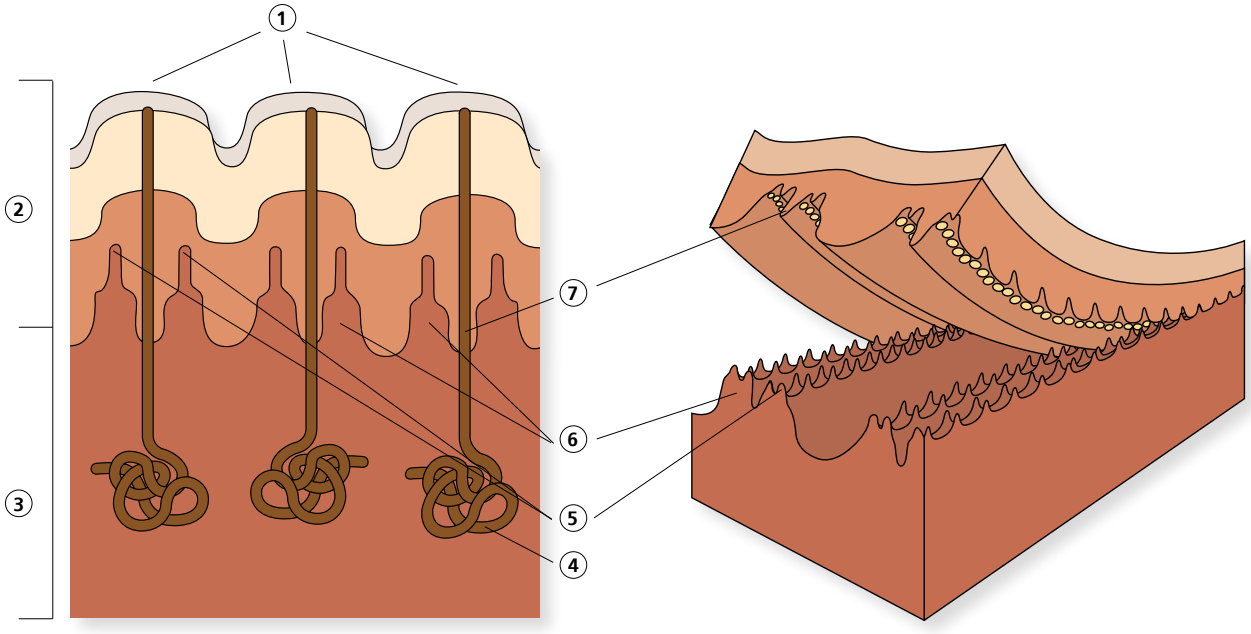


Fig. 1.2.4.:
Dermoepidermal connection:
1) Epithelium 2) Epidermis 3) Dermis 4) Eccrine sweat glands 5) Stratum papillare 6) Papillary rim 7) Interpapillary channels

Cellular components:
Fibroblasts are typical connective tissue cells, whose products mainly contain collagen, which ensures an increased firmness of the extracellular matrix together with the proteoglycans that are also formed here. Fibroblasts are the active metabolic form, while fibrocytes are the inactive, immobile form. The conversion takes place as required. Fibroblasts synthesise, among other things, several important proteins, such as vimentin, a type 3 intermediate filament, collagen I and III, matrix metalloproteinases (collagenases and gelatinases), cytokines, chemokines, and growth factors, different immunological markers.
Histiocytes (tissue macrophages) mainly occur in connective tissue and the adventitia (outer layer around tubular organs). In the event of infections, they can be activated by cytokines and converted into macrophages. Histiocytes have the ability to perform phagocytosis, i.e. the degradation and decomposition of bacteria and dead cells.
Macrophages are phagocytic leukocytes, meaning they belong to the cells of the immune system and are used to eliminate micro-organisms by means of phagocytosis. They synthesise cytokines and hydrolytic enzymes.
Mastocytes (mast cells) are found in the superficial dermis, skin appendages and the subcutis. Their cytoplasm contains many granules with heparin, histamine and metalloproteinases (i.e. enzymes which can split the peptide bonds of a protein). Mastocytes play an important role in IgE-mediated allergies such as asthma, allergic rhinitis and systemic anaphylaxis. At first contact with an allergen, the person remains symptom-free but the formation of specific IgE antibodies by the plasma cells is triggered. These target the allergen in question. The IgE antibodies settle with the foot part on the surface of the mast cells and sensitise them for the reaction to the allergen. It's only upon second contact with the allergen that an allergic reaction occurs, when the allergens bound to two neighbouring IgE antibodies on the mast cells and are thus networked with them. In this way, the mastocytes release histamine (degranulation). Histamine binds to the receptors of the surrounding tissue cells and triggers violent reactions within a few seconds (immediate allergic reaction): vessels dilate, liquid is deposited (formation of rash) etc.
Dendritic cells are sometimes only distantly related cell types that are grouped together as "dendritic cells" due

to their function. Together with monocytes, macrophages and B lymphocytes, they are "professional" antigen-presenting cells of the immune system. Their function is generate and present antigens previously recognised as foreign and intracellularly absorbed structures such as microorganisms and their components.

Fibril components:
The connective tissue of the dermis contains fibres made from collagen, elastin, reticulin and fibronectin.
Collagen is a structural protein primarily occurring in the extracellular matrix of the connective tissue. In the human body, collagen contains a third of the total mass of all proteins (about 6% of body weight). Collagen consists of individual protein chains, which form left-handed helix. In each case, three of these helices are then arranged in a right-handed superhelix. The predominant amino acids are glycine, proline and hydroxyproline. Collagen fibres have an enormous tensile strength and are virtually unstretchable. The tight winding is crucial for this high tensile strength.
Reticulin fibres are smaller and softer than collagen fibres, are densely branched and form a three-dimensional network in the extracellular matrix. They are structured similarly to collagen molecules but a higher proportion of glycoproteins. Reticulin fibres of the skin are primarily found near the basal membrane, where, together with specialised collagen fibres and fibronectin, they contribute to the dermal-epidermal junction.
Elastin is a protein network and gives the skin great elasticity. The composition of elastin is similar to collagen, but contains a large proportion of valine (15.6%) and no hydroxylysine. Lysine residues can be oxidised to allysine by the enzyme lysyl oxidase. Three allysine and one lysine can be converted into an annular desmosine, which contributes to the elasticity of the whole molecule. Elastin is secreted by the cells in a soluble form and then crosslinked by the enzyme lysyl oxidase (LOX). The amino acid lysine is responsible for this cross-linking.
Fibronectin is a glycoprotein of the extracellular matrix and plays an important role in tissue repair and the cell migration and adhesion, among other things. The soluble variant of fibronectin is synthesised in the liver and incorporated into wound healing and blood clotting in the fibrin clot. It accelerates tissue generation by binding keratinocytes, fibroblasts and cells of the immune system. Insoluble fibronectin is formed by fibroblasts, chondrocytes, endothelial cells and macrophages and incorporated into the extracellular matrix. It combines cells with the extracellular matrix („cellular glue") here.

Base substance:
The base substance is an amorphous gel of the intracellular matrix, which consists of 95% glycosaminoglycans (GAG) and 5% proteins. The most important glycosaminoglycans of the skin are hyaluronic acid, chondroitin sulfate, dermatan sulfate, heparan sulfate and keratin sulfate. Except for hyaluronic acid, all GAGs are bound to proteins, thus forming proteoglycans. These account for about 10-20% of the extracellular matrix and have a substantially role in their metabolic, immunological and tissue healing processes. Proteoglycans are polyanionic, i.e. they have multiple negative charges, and can therefore polymerise and bind large amounts of extracellular fluid.

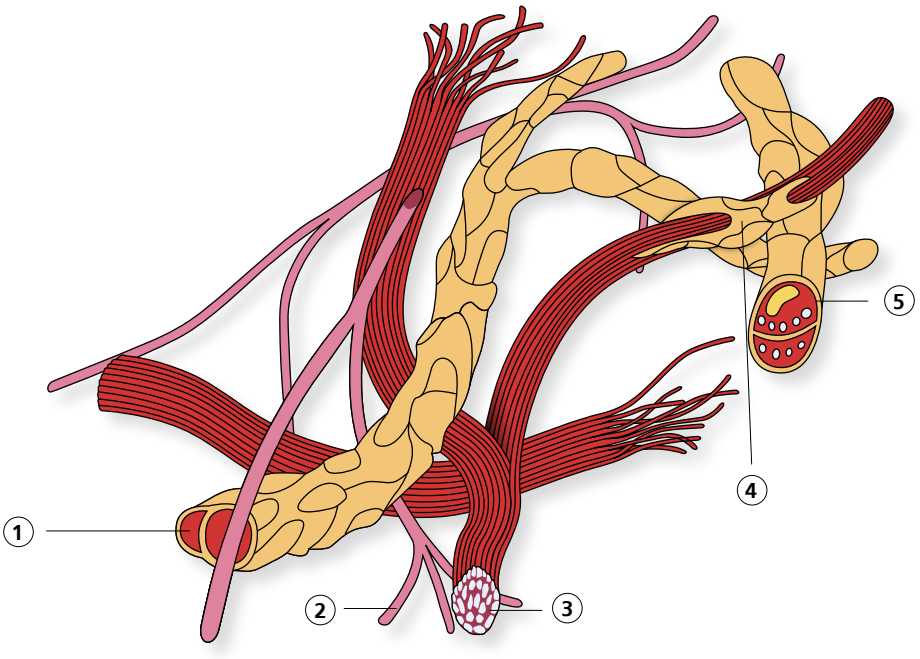


Fig. 1.2.5:
Connective tissue: 1) Capillary vessel; 2) elastic fibre; 3) collagen fibre; 4) fibroblast; 5) peripheral nerve

1.2.3 Subcutis

The subcutis is mostly loose connective tissue, which connects the upper layers of skin to the underlying structures (periosteum and fascia) via septa. There is fatty tissue between the connective tissue septa. The subcutaneous tissue has an average thickness of 0.5 to 1 cm in people of normal weight.
The subcutis is crisscrossed by the blood vessels and nerves supplying the skin. Skin appendages such as hair roots and glands, which are actually components of the dermis, can protrude into the subcutis. The Vater-Pacini corpuscles (mechanoreceptors of the skin) are mainly located in the subcutis of palms and soles.
The subcutaneous adipose tissue stores energy in the form of fat, protects against pressure, keeps you warm in winter and protects from heat in the summer.

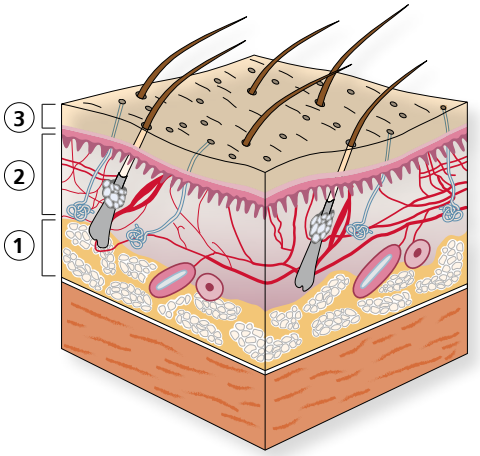


Fig. 1.2.6:
1) Subcutis 2) Dermis 3) Epidermis

1.2.4 Skin Appendages

In addition to the three layers of skin, the skin also contains skin appendages: **hair** and **nails**, **sebaceous and perspiratory glands**. They originate from the epidermis, but extend deep into the dermis and sometimes into the subcutis too.

Hair:
The visible hair has a great wealth of variations when it comes to thickness, colour and structure, and is made up of three layers: cuticle (scaly layer), cortex (fibre layer) and medulla (marrow).
The outermost layer, **cuticle**, consists of six to ten layers of flat, overlapping, horny, dead cells. When hair is healthy, the cuticle lays flat and provides a smooth, translucent surface. The light is reflected really well, giving hair its shine. The **cortex** makes up about 80% of the hair and consists of fibre bundles, which, in turn, are made up of a large number of fine keratin fibres. The **medulla** is the medullary canal of the hair, contains many lipid-like cells and ensures versatility and, in parts, mechanical resistance. The hair root is located in the lower area of the dermis, where the hair grows on the hair papilla. Numerous melanocytes are stored in the matrix, releasing their pigments to the resulting hair. The keratin-rich horn cells migrate to the top and form the hair shaft, which pushes its way to the surface of the skin within the follicle.
The **hair follicle** consists of the parts of the hair that protrude into the skin (not visible) and the adjacent structures (sebum glands, hair arrector muscles, apocrine sweat glands, blood vessels, nerves). The actual hair follicle is an epithelial invagination and contains the hair root (radix pili) and the hair shaft (scapus). A sebum gland opens into the follicle, along with a scent gland on occasion.
A hair cycle is divided into three phases:
Anagen phase: a new hair root is formed, and the production of a hair begins. The anagen phase lasts around two to six years in human scalp hair, depending on age, gender and specific location. Approximately 85-90% of head hair are in this phase.
Catagen phase: in this transition phase, the hair root ceases cell production and the hair follicle narrows at the bottom. The hair detaches from the papilla and withers. The hair follicle becomes shorter. About 1% of all hair is in this phase.
Telogen phase: in this final phase, which contains up to 18% of the scalp hair, the hair papilla is renewed and the hair follicle regenerates. The matrix is formed again and begins cell division, so a new hair is formed

Nails:
Nails are skin appendages of epidermal origin, have a keratin composition similar to that of hair and are located on the tips of the fingers and toes. Nails consist of a nail plate and a nail bed. The **nail plate** consists of 100 to 150 layers of corneocytes and is about 0.4 to 0.6 mm thick. The nail formation (onychisation) is a cornification deep behind the nail fold without the formation of the keratohyalin intermediate stage. Different nails grow at different speeds, on average about 0.1 mm per day. The nail plate is formed at the nail root. The eponychium is the epithelium, which is located on the nail plate, while the hyponychium is under the nail plate. The connective tissue-like **nail bed** is beneath the hyponychium, fused firmly with the periosteum of the distal phalanx. The hyponychium becomes the matrix in the region of the nail root and forms the substance of the nail plate. The corresponding area is known as the lunula. The sides of the nails are surrounded by a fold of skin, the nail wall. The perionychium (cuticle) refers to the visible part of the skin lying directly on the nail wall towards the back of the nail plate.

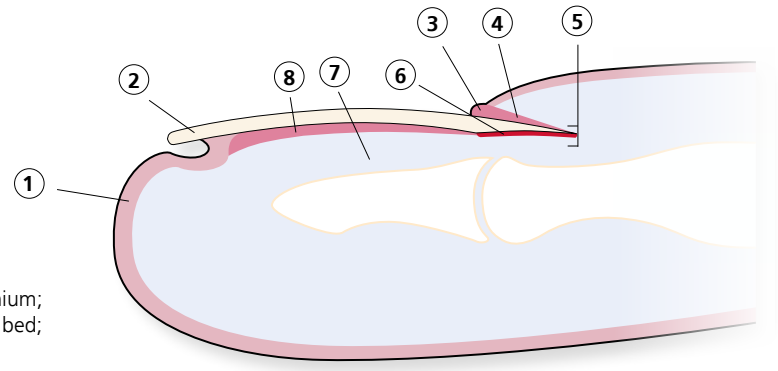


Fig. 1.2.7:
Nail anatomy: 1) Epidermis; 2) Nail plate; 3) Perionychium; 4) Eponychium; 5) Nail pocket; 6) Matrix; 7) Nail bed; 8) Hyponychium

Sweat glands (glandulae suderiferae):
The human body has eccrine (merocrine) and apocrine (holomerocrine) sweat glands. **Eccrine sweat glands** have a diameter of 0.4 mm and are surrounded by a thick basal membrane. These sweat glands are located on the border between the dermis and the subcutis. There are about 100 to 600 per cm^2. Eccrine sweat glands regulate the heat balance by means of evaporation. Sweat is slightly acidic and thus regulates the pH value of the skin. In addition, on a smaller scale, they undertake the excretion of urinary substances and excrete substances with antibacterial effect. The **apocrine sweat glands** ("scent glands") only occur in certain skin areas (armpit, nipple, genital and perianal region) and are significantly larger, with a diameter of 3 to 5 mm. This type of sweat gland is located in the subcutis and opens into the excretory ducts of hair follicles. Apocrine sweat glands are not formed until puberty. The production of secretion is activated particularly by emotional stimuli. In addition to pheromone-like scents, they release other substances into the hair follicle, which are only converted into various odours when mixed with sebum under the influence of skin bacteria.

Sebaceous glands (glandulae sebaceae):
The sebaceous gland is a lipid-producing gland in the upper part of the dermis. Most sebaceous glands are located on hair follicles (up to five glands per follicle). The others, known as "free" sebaceous glands, are mainly in the nostrils, in the lip vermilion and in the genital area. The sebum keeps the hair and the stratum corneum smooth and protects against skin diseases, pathogens and chemicals.
The sebaceous gland wall has a germ layer, which constantly produces new sebocytes (= sebum-producing cells). These cells migrate into the middle of the gland and start producing lipids, which accumulate in the cells. By the time they reach the centre of the gland, they have accumulated so many lipids that they burst. This sebaceous pulp pushes up through the end of the follicle to the skin, breaking cornified cells from the follicle wall as it pushes up and taking them up with it to the skin. The sebum is made up of approx. 43% triglycerides, 15% free fatty acids, 23% waxes, 15% squalenes and 4% cholesterol.

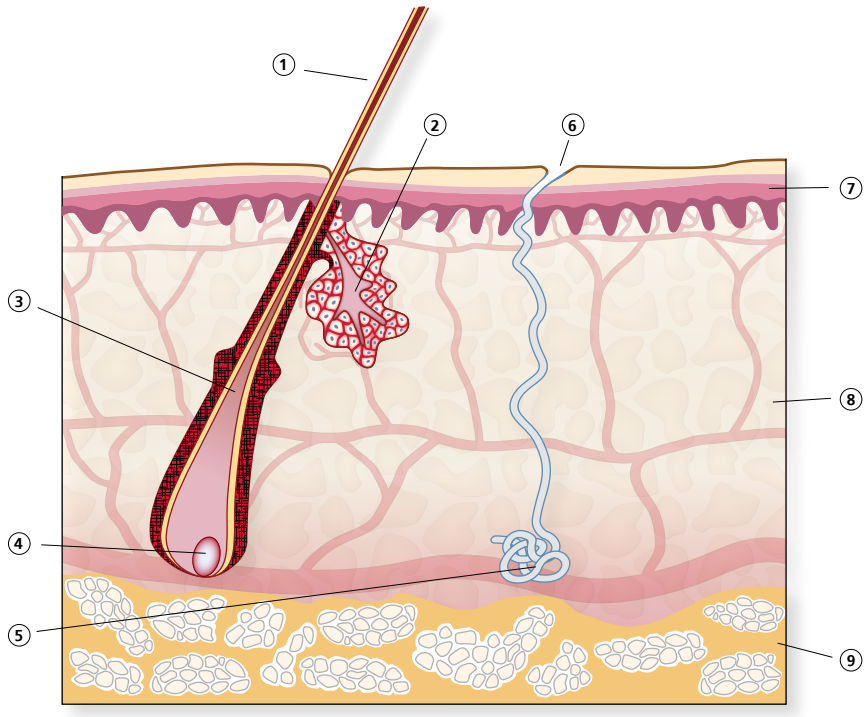


Fig. 1.2.8:
Skin appendages:
1) Hair
2) Sebaceous gland
3) Hair follicle
4) Hair papilla
5) Sweat gland
6) Sweat pore
7) Epidermis
8) Dermis
9) Subcutis

1.2.5 Formation of Cutaneous Blood Vessels

Our skin has an extensive network of arterial, venous and lymphatic vessels, which play an important role in thermoregulation, hemodynamics, metabolism and defence.

Arterial skin vessels:
According to their origin and function, cutaneous arteries are divided into

- **direct** or **axial skin arteries**, which emerge from important segmental vessels, have a subcutaneous alignment and supply certain areas
- **fasciocutaneous** or **septocutaneous arteries**, which also emerge from important segmental vessels and have a subcutaneous alignment, but pass through an inter-muscular partition (septum)
- **myocutaneous arteries come** from important muscular arteries, their branchings run through the muscle and are distributed into the skin that is directly above.

In the subcutis, the arteries branch out really widely, forming the arterial subcutaneous tissue. From here, the actual skin vessels emerge as vertical skin arteries, which connect to one another, forming the intermediary arterial network of the skin and subsequently the superficial arterial network of the skin. From the uppermost plexus, a densely branched capillary system descends, which supplies every single papilla and then opens into the venous capillary system.
The following vascular layers are seen when viewed from bottom to top:

- Segmental artery
- Axial cutaneous, septocutaneous and myocutaneous branches
- Subfascial plexus
- Prefascial plexus
- Subcutaneous plexus
- Subdermal plexus
- Intermediary dermal plexus
- Papillary or subepidermal plexus

The blood flow to the skin is regulated by many arteriovenous anastomoses. These connections open and close depending on the needs of the skin regions in question, in accordance with the needs of the rest of the body.

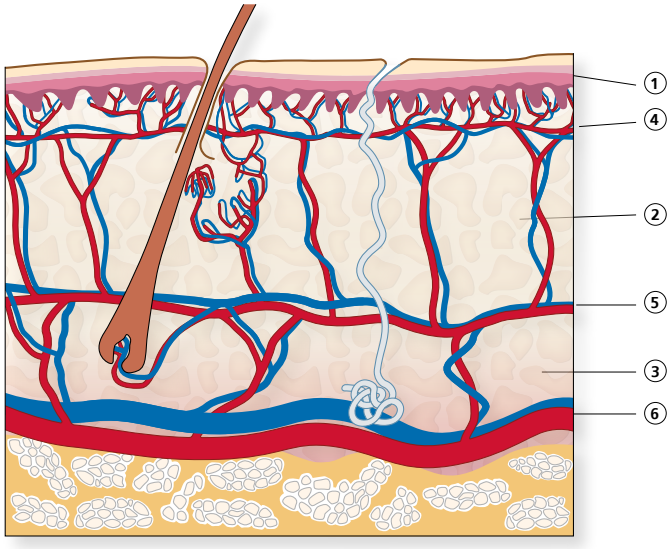


Fig. 1.2.9:
Cutaneous perfusion:
1) Epidermis
2) Dermis
3) Subcutis
4) Subpapillary plexus
5) Subdermal plexus
6) Subcutaneous plexus

Venous skin vessels:
The venous bloodstream coincides with the arterial one. Each small artery has a concomitant vein with a direct cross connection (anastomosis). These anastomoses regulate the papillary blood flow according to the need, for example, in case of cold, superficial injuries, inflammation, sepsis, allergic processes, the influence of medications, etc.

Lymphatic skin vessels:
The lymphatic system's main job is to drain the interstitial space. The lymph capillaries drain first into the subpapillary lymphatic plexus and then into the subdermal plexus, from where the lymph fluid is guided to the regional lymph nodes by means of subcutaneous lymph vessels.

1.2.6 Cutaneous Nerve Fibers

One of the main tasks of the human skin is sensory perception, such as touch, temperature, pain, pressure. The nerve supply to the skin can be divided into two large groups, **afferent fibres** and **efferent fibres**.
The **afferent nerve endings** of the skin can, in turn, be divided into two broad categories: free nerve endings and encapsulated nerve endings. Free nerve endings are myelin-free nerve endings (have no myelin sheath), which are predominantly found in the stratum basale of the epidermis and in the upper dermis, in the stratum papillare. Encapsulated nerve endings have a more complex structure and are only found in the dermis and subcutis. They have a lamelliform and non-lamelliform outer later made of interconnected cells and collagen fibres and an inner layer of nerve fibres. **Vegetative nerve endings** are myelin-free efferent nerve endings, which initially still move together with the afferent fibres, and are then distributed into the blood vessels, sebaceous glands of hair follicles and sweat glands. The adrenergic fibres trigger a vasoconstriction, i.e. the blood vessels constrict, while the cholinergic fibres cause vasodilation (vessel dilation) and stimulation of sweat secretion.

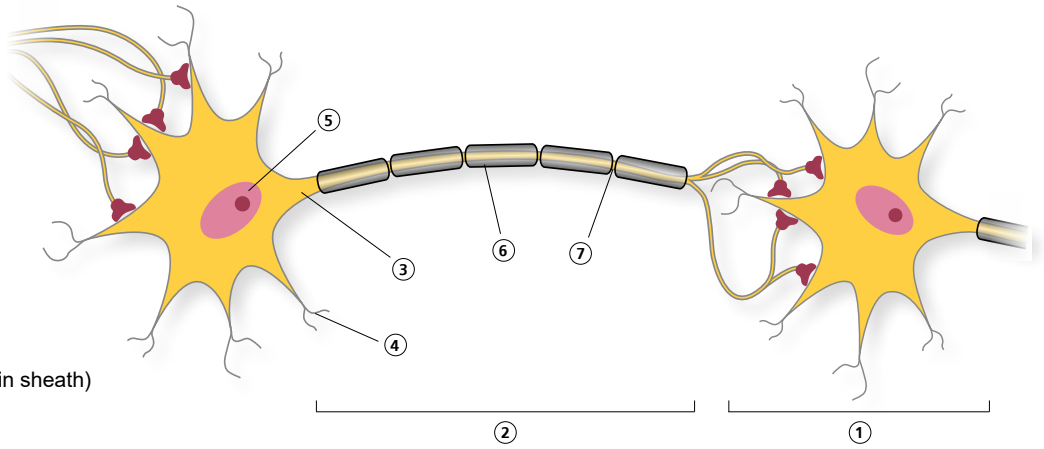


Fig. 1.2.10:
Nerve cell:
1) Cell body (soma)
2) transmission (axon)
3) Axon hillock
4) Dendrites
5) Nucleus
6) Medullary sheath (Myelin sheath)
7) Ranvier lacing ring

1.2.7. Skin Functions

The skin has numerous functions, but mainly a protective function, a function as a sensory organ and metabolic function:

1.2.7.1. Protective function:

The protective function is the skin's most complex task. All three functions are closely related to one another and act together.

- **Mechanical protection**
  The skin withstands a certain degree of mechanical stress, such as pressure, drag, rotation, etc. and thus also protects the subcutaneous structures such as blood vessels, nerves, muscles, tendons, internal organs. Mechanical protection is based on the visco-elastic properties of the skin, on the basis of its special structure (see previous chapter). Our skin is able to elastically deform. After mechanical stress, it returns to its original shape. However, if the mechanical forces are too great or last too long, the skin suffers permanent damage with stretching or depth: stretch marks, abrasions, wounds, etc. The subcutis also has an important protective function as a cushioning layer, due to the storage of fatty tissue.
- **Chemical protection**
  Most acids (excluding hydrofluoric acid), which inadvertently get on the skin, are quickly neutralised: First, by the lipid protective film, then by the skin proteins, mainly collagen. Alkalines, on the other hand, cause more severe and, above all, deeper injuries, as they saponify the fats and hydrolyze the protein complexes.
- **Protection against photochemical influences**
  This occurs through the synthesis and storage of melanin, which acts as a „protective shield" that absorbs ultraviolet radiation, thus protecting subepidermal structures.
- **Protection against biological influences**
  Protection against biological aggressors, mainly bacteria, fungi, viruses, is another very important characteristic of the skin. This is made possible among other things through the greasy layer on the skin, which has bacteriostatic and even bactericidal properties.
- **Protection against liquid and plasma loss**
  The skin is almost impenetrable and protects the human organism from both loss of fluid and the penetration

of various substances into the body. This is made possible through the synthesis and storage of keratin (protein) in epidermal cells, through the synthesis and storage of eleidin, a lipid that helps to make the upper layers of the epidermis impervious, and through a lipid film produced in the sebaceous glands.

- **Thermoregulation**
  Skin is thermoregulated with the help of two important components: Cutaneous perfusion and perspiration
  The skin has lots of interwoven blood vessels, which are fitted in layers with lots of arterial-venous shunts and equipped with vascular tuft-like structures.
  When exposed to the cold: thermal protection by a thermal insulating layer, the subcutis; reduction of normal heat loss through a reduction in blood flow to the skin (by means of blood vessel constriction/vaso-constriction), especially in areas exposed to the cold.
  When exposed to heat: blood vessel dilatation (vasodilation) and sweat production; the resulting evaporation cooling causes additional heat loss. A similar phenomenon occurs with a fever.

1.2.7.2. Sensory and communicative function:

The skin is the connection between the organism and the environment, it receives and transmits a multitude of information. A large number of skin receptors sends constantly information to the brain regarding the environmental conditions to which the organism is exposed (temperature, humidity, etc.). Through our skin, we receive constant information to us to interact with the environment and other people. But the skin also transmits information about our emotional state and about the physiological and pathological situation (e.g. age, diet, fever, various diseases, which are displayed on the skin).

1.2.7.3. Metabolic function:

The metabolic function, the synthesis function and the function of regeneration actually form a complex, in which these three functions work together in synergy. Some of the features have already been mentioned in previous chapters:

- Synthesis and secretion: Many proteins and lipids are produced in the skin, for example keratin, eleidin, sebum, melanin, etc.; vitamin D is also synthesised in the skin, initially converted into previtamin D3 by conversion of 7-dehydrocholesterol through photolysis with UVB light with wavelengths of 270-315 nm and then further into vitamin D3 by thermal isomerisation.
- In some layers of the skin, certain hormones are produced, which play a role in regulating metabolic process and regenerating the skin.
- In certain situations, the skin becomes an auxiliary excretory organ, through which water, mineral salts, heavy metals and some metabolic products such as urea are excreted.
- The skin is also an important target organ for hormones, particularly for sex hormones, which determine secondary sexual characteristics at skin level: texture, elasticity, hairiness, etc. The largest consumer of testosterone is the hair follicle-sebaceous glands complex.
- In addition, the skin is one of the most important organs for "storing" blood due to its vascular network. If all anastomoses (connections) of the skin's vascular system were open, the body's entire blood volume could be accommodated in the skin. In the event of severe blood loss, the skin mobilizes the stored blood and sends it into the bloodstream for the vital organs (brain, heart, lungs, etc.). The skin actively intervenes in the coagulation process by means of thromboplastins/blood coagulation factors and subsequent vasoconstriction (this leads to the cutaneous manifestations of haemorrhagic shock - pallor, hypothermia, cold sweat, etc.).
- But the most important function is that of tissue repair and wound healing. The epidermis is one of the few organ structures in the human body that can be completely restored without scarring (starting from the basal membrane). Injuries to the dermis heal with scarring, since the cell architecture of the collagen fibres is never the same after healing as it was before the injury.

Chapter 2: Wound Healing

A wound is any morphological and functional destruction at the skin level, caused by various external and/or internal factors. Wound healing is a complex biological process, during which the injured organism tries to wholly or partially restore the affected structure. If the architecture and function of the injured tissue or organ is completely restored, we refer to this as regeneration or "restitutio ad integrum". Complete healing occurs in epithelial tissues, the liver parenchyma, the bones and some smooth muscles, etc.
If the affected structures are, however, replaced with new "filler tissue" that contains a lot of collagen and is not similar to the original tissue from an anatomic nor functional point of view, we speak of partial recovery ("Reparatio") or scarring.
Numerous exogenous and/or endogenous circumstances can lead to the destruction of the skin, here are a few examples:

Exogenous factors: burns (thermal, chemical, electrical), mechanical trauma (contusion, crushing, etc.), ionising radiation, infections

Endogenous factors: cutaneous ulcerations of various aetiologies, pressure sores (bedsores), diabetic foot ulcers, neoplasms, etc.

2.1. Types of Tissue Repair

Galenus of Pergamon, born 129 AD in Pergamon, † 200 AD in Rome, a Greek physician and anatomist, postulated two main types of cutaneous wound healing:

- **Primary wound healing or per primam intentionem:**
  Primary wound healing occurs in aseptic, uninfected lesions with sharply demarcated margins and a small area of destroyed tissue. These wounds which are caused by sharp objects (e.g. surgical wounds or cuts) have wound edges that are close together, with hardly any loss of substance, which means the wound closure leads to a barely visible scar with a functionally and cosmetically acceptable result.
- **Secondary wound healing or per secundam intentionem:**
  Secondary wound healing is the usual wound healing in extended lesions with tissue loss and gaping wound margins. The wound must first be refilled with granulation tissue. Then, epithelial cells migrate from the wound edge and settle on top of the granulation tissue. The scarring is very pronounced.

From a surgical point of view, there is also a third type of wound healing, known as tertiary or delayed wound healing.

The wound healing process is divided into five phases:

- **Haemostasis** (arrest of bleeding)
- **Exudation phase** (inflammation phase, cleaning phase)
- **Proliferation phase** (granulation phase)
- **Repair phase** (epithelisation phase)
- **Remodelling** (maturation phase, scarring)

With the healing of chronic wounds, the exudation, granulation and epithelisation phases are particularly important, so we will only go into these three phases in more detail in Section 2.2. Due to the general irrelevance in chronic wounds, we will not describe haemostasis and remodelling.

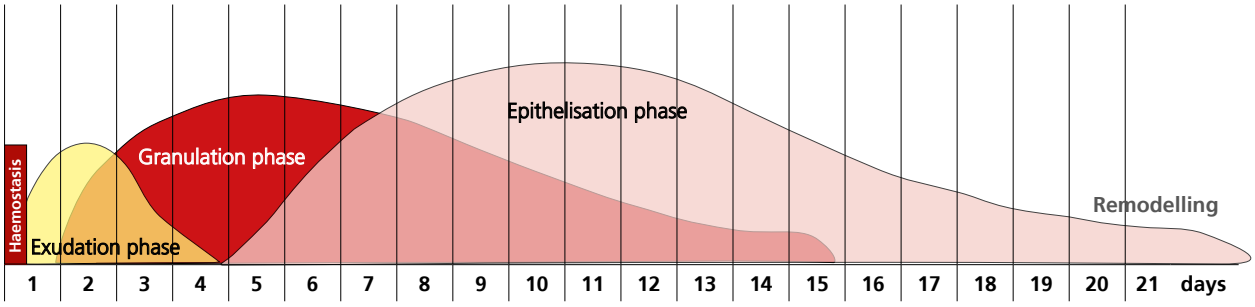


Fig. 2.2.1:
Example of wound healing phases in primary wound healing.

2.2. Wound Healing Phases

The subdivision is only theoretically, as the phases of wound healing overlap, with some occurring in parallel. Especially with chronic and secondary healing wounds, the lengths of the individual phases can vary greatly. These complex and partially overlapping processes of wound healing are controlled by cytokines and growth factors.

2.2.1 Exudation phase (cleaning phase)

When clotting, a fibrin network is formed, which enables the adjacent edges of the wound to bond. Thrombocytes release growth factors freely, which initiate further wound healing processes. Neutrophilic granulocytes migrate into the wound and engulf invading germs and tissue necroses. Wound secretion, which is permeated with inflammatory cells, washes out cell debris (detritus) and germs. In the course of this phase, cell division in the wound area increases, macrophages dispose of the cell debris and the clot, where necessary. Fibroblasts accomplish the actual construction work in the next phase. A moist wound environment is necessary for this, which is maintained using modern dressings.

2.2.2 Proliferation phase (granulation phase)

After the immigration of fibroblasts and the accumulation of endothelial cells, the defect is gradually filled in through the proliferation of vessel-rich granulation tissue (filling connective tissue). The wound is deep red, shiny, moist and hardly exuding.

2.2.3 Repair phase (epithelisation phase)

Contraction of the wound through the release of fluid and through the formation of new surface cells and subsequent cell migration from the edge of the wound to the centre of the wound. Rapid epithelisation requires a well-formed granulation tissue. The epithelial cells „slide“ over the new granulation tissue from the wound edge. If two keratinocytes meet, migration stops. The cells anchor themselves on the granulation tissue and form the new basal membrane. The granulation tissue forms increasing amounts of collagen fibres, thereby creating fibre-rich scar tissue. Since no elastic fibres are formed, the scar tissue has no elasticity. For this reason, minimal scarring is desirable.

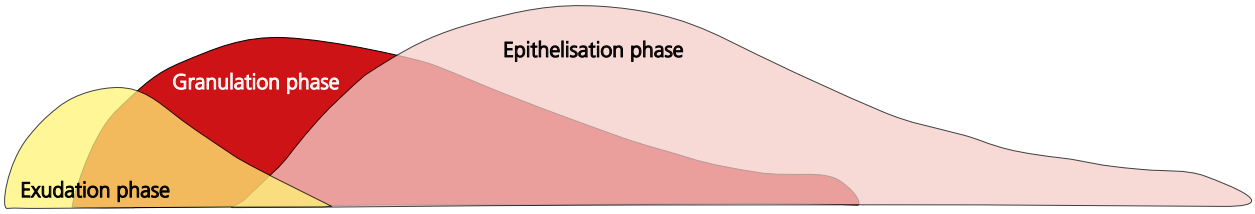


Fig. 2.2.2:
Example of wound healing phases in chronic secondary healing wounds

2.3 Cytokines and Growth Factores

Thrombocytes, neutrophilic granulocytes, macrophages, fibroblasts, myofibroblasts, endothelial cells, keratinocytes, immune cells, etc. are involved in all phases of the healing process.
These cells communicate with each other through **mediators, which regulate the cell growth, cell differentiation and inflammatory reactions, the cytokines**. Cytokines are proteins that are mutually influential over the ways they work and that are believed to form a complex network.
According to current knowledge, the following cytokines are involved in the healing of skin defects. The names are in English, as these are the common terms used in specialist literature.

- **PDGF** (platelet derived growth factor)
  Is released in the event of injury to thrombocytes (platelets). Chemotactic and mitogenic factor for fibroblasts, granulocytes and monocytes; stimulates angiogenesis and contraction of wounds; promotes the synthesis of the extracellular matrix and the morphogenesis of the granulation tissue.

- **TGF-α** (transforming growth factor alpha)
  Has a chemotactic and mitogenic effect on fibroblasts and keratinocytes; promotes keratinocyte migration.

- **TGF-β** (transforming growth factor beta)
  Has a chemotactic and mitogenic effect on fibroblasts; promotes angiogenesis and formation of the extracellular matrix.

- **EGF** (epidermal growth factor)
  Chemotactic factor; promotes the migration of keratinocytes; stimulates the proliferation of keratinocytes and fibroblasts; promotes angiogenesis.

- **FGF** (fibroplast growth factor)
  In fibroblasts, keratinocytes, and endothelial cells, this growth factor causes chemotaxis and promotes proliferation. In addition, it stimulates angiogenesis, the structure of the extracellular matrix and the formation of granulation tissue.

- **KGF** (keratinocyte growth factor)
  Stimulates the differentiation, proliferation and migration of keratinocytes.

- **TNF-α** (tumour necrosis factor alpha) and **TNF-β** (tumour necrosis factor beta)
  Activate granulocytes and macrophages; stimulate the division of fibroblasts and encourage angiogenesis.

- **IL-1** (interleukin-1)
  Multifunctional cytokine, regulates the function of lymphocytes and monocytes; inflammation-promoting signal substance, can trigger a rise in temperature (fever); promotes the production of TNF-α and INF-γ; promotes blood formation (haematopoiesis).

- **IL-2** (interleukin-2)
  Activates cytotoxic T-lymphocytes and killer cells; promotes differentiation of B-lymphocytes and proliferation of B-lymphocytes and T-lymphocytes.

- **IL-4** (interleukin-4)
  Indicates the growth of B-lymphocytes; growth factor for T-lymphocytes and mast cells; activates macrophages; promotes proliferation of haematopoietic stem cells.

- **IL-6** (interleukin-6)
  Multifunctional cytokine with pro-inflammatory effect: stimulates the synthesis of acute phase proteins, can trigger a rise in temperature (fever); promotes differentiation of B-cells from plasma cells; keratinocyte growth factor; stimulation of the liver metabolism.

- **IL-7** (interleukin-7)
  Promotes the proliferation of so-called pre-B cells; acts as a growth factor for T-lymphocytes; promotes the chemotaxis of neutrophilic granulocytes and the expression of adhesion molecules.

- **IL-8** (interleukin-8)
  Inflammatory and chemotactic cytokine; promotes the chemotaxis of neutrophilic granulocytes and the expression of adhesion molecules.

- **IL-10** (interleukin-10)
  Plays an important role in limiting and restricting the inflammatory response, controls growth and differentiation of various immune cells, keratinocytes and endothelial cells.

- **IFN-α** (interferon alpha), **IFN-β** (interferon beta), **IFN-γ** (interferon gamma)
  Are mainly produced by leukocytes (IFN-α), fibroblasts and epithelial cells (IFN-β) and lymphocytes (IFN-γ); have a chemotactic effect on macrophages, promote phagocytosis and limit the proliferation of fibroblasts.

- **TXA2** (thromboxan A2)
  This eicosanoid is produced in the thrombocytes and is used for platelet aggregation and vasoconstriction.

- **GM-CSF** (granulocyte macrophage colony-stimulating factor)
  Has a mitogenic effect on keratinocytes, stimulates the migration and proliferation of endothelial cells; helps with the introduction of secondary cytokines.

- **IGF** (insulin-like growth factor)
  Insulin-like polypeptides that aid cell growth and differentiation.
- **CTGF** (connective tissue growth factor)
  Has a chemotactic effect on fibroblasts, promotes synthesis of collagen and formation of the cellular matrix.
- **HB-EGF** (heparin-binding epidermal growth factor)
  Mitogenic and chemotactic growth factor in fibroblasts and keratinocytes.
- **VEGF** (vascular endothelial growth factor)
  Regulates vasculogenesis and angiogenesis.
- **NGF** (nerve growth factor)
  Promotes growth and differentiation of peripheral nerve cells.

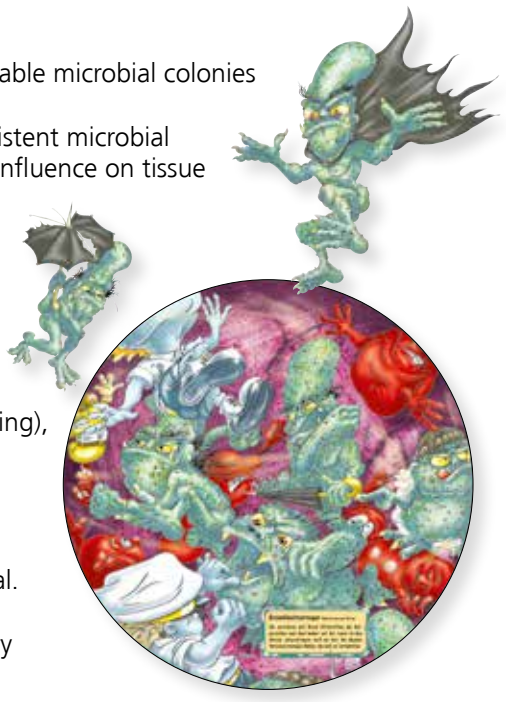
2.4 Chronic Wounds

Chronic wounds go through the same wound healing phases as acute wounds, but with a significantly longer healing process. Typical clinical, biochemical, cellular and bacteriological characteristics of chronic wounds and possible long-term effects:

- **Clinical characteristics**:
  Gangrene, fibrin layers, necrosis, poor blood circulation, no normal granulation tissue, no or insufficient epithelisation, frequent recurrences and/or deterioration in wound healing
- **Biochemical characteristics**:
  Increase in pro-inflammatory cytokines, metalloproteinases, gelatinases, stromelysin, serum proteases, etc.
  Decrease of tissue inhibitors of matrix metalloproteinases (TIMP) and protease inhibitors alpha1 and alpha2.
  Stronger degradation of fibronectin, vitronectin and tenascin
- **Cellular characteristics**:
  Decreased cell division activity, increased phenotypic cell changes, presence of senescent cells, increased activity of growth factors
- **Bacteriological characteristics**:
  Increased levels of pathogens, the presence of several microbial strains, the presence of multi-resistant bacterial strains, the presence of a bacterial protective film against immunological and antibiotic aggressors
- **Long-term effects of chronic wounds**:
  Formation of fistulas, purulent sinuses and chronic abscesses; occurrence of chronic osteomyelitis, contractures and deformation of joints, degeneration of chronic ulceration, systemic amyloidosis, heterotopic ossification and calcification

The above biochemical changes mean the inflammatory symptoms in the wounds continue with a significant increase of the free radicals produced by PMNs (polymorphonuclear neutrophils). This leads to an inhibition of macrophage performance and the reduction of the release of cytokines and growth factors, which stimulate cell migration and proliferation of fibroblasts, keratinocytes and endothelial cells.
The phenotypic changes can be seen especially in fibroblasts, keratinocytes and endothelial cells. The fibroblastic modifications cause a decrease in collagen synthesis and the production of cytokines and growth factors. This leads to insufficient formation of new capillaries and, together with the continuous breakdown of the matrix, to an inhibition of angiogenesis. The formation of granulation tissue is not or only insufficiently possible in these circumstances.
The lack of granulation tissue, cytokines and growth factors block epithelisation. Over time, the rate of division of fibroblasts, epithelial and endothelial cells slows and premature cell ageing occurs. The reduced fibroblastic division and migration leads, on one hand, to an inhibition of wound contraction and, on the other hand, to the acceleration of apoptosis (programmed cell death).
The accumulation of nitric oxide (NO) and its combination with free oxygen radicals leads to the formation of peroxynitrites with a cytotoxic effect, causing necrosis and fibrin films, which are an excellent culture medium for bacteria.
The following are the stages of bacterial colonization:

- **Bacterial contamination**: Presence of pathogens in the wound, stable microbial colonies with no significant tendency to multiply
- **Bacterial colonisation**: Presence of pathogens in the wound, persistent microbial colonies with tendency to propagate, but without any noteworthy influence on tissue and organism
- **Critical colonisation**: Presence of a large number of pathogens, the bacterial colonies multiply vigorously and spread in the infected area. Daily dressing changes necessary.
- **Local infection**:Presence of a very large number of pathogens, the bacterial colonies continue to multiply vigorously and spread in the infected area, still without systemic infection or septic dissemination. Features: Dolor (pain), calor (warmth), tumour (swelling), rubor (reddening), function laesa (functional restriction).
  Daily dressing changes are essential.
- **Generalised infection**:
  Initial propagation on wound level, pathogens multiply quickly and spread over the entire organism. Daily dressing changes are essential.



Bacterial endotoxins lead to a deterioration of the chronic inflammatory symptoms and can delay or even prevent the healing process.

There are also a number of systemic factors that increase the risk of chronic wound infection: vascular disease, radiotherapy, oedema, smoking, diabetes mellitus, corticosteroids and/or immunosuppressive therapy, malnutrition, recent surgery, congenital (hereditary) changes in neutrophilic granulocytes.

In addition to the clinical and biological characteristics of chronic wounds, there are also numerous pathological states that can lead to chronification:

- Neuropathies (diabetes mellitus, cerebral and spinal lesions, leprosy)
- Ischaemias (arteriosclerosis, vascular calcifications, diabetic angiopathy, vasculitis)
- Peripheral oedema (venous hypertension, kidney failure, heart failure, lymphoedema, hypoalbuminaemia, lymphatic filariasis, etc.)
- Risk of bedsores due to mentally motivated hypomotility, dementia, paraplegia and quadriplegia, old age, terminal stage, etc.

Moreover, corticosteroid therapy and/or hydroxyurea regulation, debilitating systemic diseases, cancers, chronic osteomyelitis, smoking, malnutrition, alcohol abuse, etc.

In addition to these pathological changes, which lead to a delay in wound healing, there are also normal physiological changes, i.e. the **normal ageing process of the organism**.
Senescence (old age) has major influence on all wound phases, especially after you turn seventy:

- The metabolic turnover of the epithelial cells is reduced, just as the life expectancy of individual cells
- Flattening of the dermal-epidermal connection, causing a reduction in mass transfer between the two skin layers. Since the epidermis does not have its own vascular system, it is supplied by the underlying skin layer.
- Reduction in the number of dermis cells, with a simultaneous decrease in the synthesis of components of the extracellular matrix; cells involved in the healing process also reduce their receptors for cytokines and growth factors, and react correspondingly slowly to stimuli
- Changes to the composition and structure of the individual components of the extracellular matrix, both of the fibre constituents (collagen, fibronectin, elastin, tenascin, vitronectin) and the non-fibrous components (proteoglycans, glycosaminoglycans, etc.) with direct effect on the healing process
- Reduction of the immune response, phagocytosis and production of pro-inflammatory cytokines, which reduces and delays the inflammatory phase, which in turn has consequences for the remaining phases of wound healing

2.5 Principles of Modern Wound Treatment

Traditional (or conventional) wound care is equated with dry wound care, gauze compresses or moistened gauze are usually used, as well as nonwoven compresses, ointment compresses, impregnated wound gauzes. These can dry out in the wound and stick to the wound bed. In this type of wound care, frequent daily dressing changes are to be expected, with a higher risk of infection and injury to the wound.
In the modern, moist wound care, however, a moist wound environment is maintained in all phases of wound healing. This speeds up the healing of wounds, which was proven by Dr. George Wunter back in 1962.

The most important criteria of a so-called modern wound treatment are:
- Promoting and maintaining physiological moisture in the wound
- Promoting and maintaining an optimum temperature of 28-32°C
- No products that cause staining
- Extended dressing change intervals (exception: critically colonized and infected wounds)

The use of hydroactive dressings provides the following advantages in comparison to traditional wound care: Faster healing, higher healing rate, fewer wound infections, less pain during dressing changes, fewer dressing changes due to longer wear times, more quality of life for the patient, and lower personnel costs due to fewer dressing changes.

Dressing materials are medical products and are generally billable at the expense of statutory health insurance

Depending on type of wound, wound healing phase and, above all, depending on the extent of secretion, the appropriate wound covering can be selected from a variety of product groups. The following list does not claim to be complete and is limited to the main product groups:

- **Activated charcoal wound dressings**
  Activated charcoal compresses consist of absorbent materials with a (mostly middle) layer of activated charcoal. The activated carbon binds bacteria, scent and protein molecules to itself.
- **Alginates**
  Alginates consist of alginic acids, which are mainly extracted from brown algae. The compositions of alginates differ depending on the manufacturer. On contact with wound exudate, the dry calcium alginate fibre absorbs the sodium-rich exudate and transforms into a soluble sodium alginate (= gel) by emitting calcium ions. The freed calcium ions cause a haemostasis, and the hydrophilic sodium alginate gel binds a great amount of liquid (about 20 times its own weight) and firmly entraps germs and debris.
- **Aquafibre dressings**
  These dressings made from two bicomponent fibres are particularly suitable for maintaining the moist wound environment during the granulation and epithelisation phase.
- **Antimicrobial wound dressings**
  These wound dressings consist of a carrier material, for example cotton compress or polyurethane foam, which is saturated with an antiseptic, usually polyhexanide. Even hydrogels provided with antiseptics are anti-microbial wound dressings.
- **Hydrogels**
  Hydrogels are supplied as transparent compresses or as gel, contain between 30 and 95% water and mostly use cellulose derivatives as gelling agents.
- **Hydrocolloids**
  They consist of a thin polyurethane film or foam with an applied carrier layer made of synthetic rubber that contains particles that swell strongly.
- **Wound dressings containing collagen**
  Porous, sponge-like wound dressings made from collagen obtained either from pig and/or bovine dermis or from horse muscles. These wound dressings must be covered with a secondary dressing, as they are completely absorbed by the body.
- **Combined wound dressings**
  They usually consist of polyurethane film or fleece, superabsorbent and hydrocolloid (or polyester fibres) and can usually be left on the wound for up to seven days.

- **Wound dressings made of foamed polyurethane** (PUR), medium to coarse-pored & mixed-pored wound dressings made of polyurethane foam can be used in a variety of ways and are suitable, among other things, for wound cleaning, wound bed conditioning, exudation promotion, granulation promotion, as a wound filler, wound protection and for absorbing exudate. This breathable dressing exerts a mechanical stimulus on the wound, which encourages local circulation when in contact with the wound.
- **Foam compresses / hydropolymers**
  Polyurethane soft foam compresses can absorb 20 to 30 times their own weight in exudate, without changing shape or size. They release the absorbed liquid when pressure is applied. Hydropolymers are polyurethane foams, which expand as they absorb exudate.
- **Foam compresses, open-pored**
  Wound dressings made of open-pored polyurethane foam are particularly suitable for wound bed conditioning and mechanical debridement. They are also used as wound fillers in negative pressure wound therapy (NPWT).
- **Superabsorbent**
  The superabsorbent polyacrylate can absorb huge amounts of exudate by forming a gel. They do not release this again (so-called Pampers principle). This creates a moist wound climate, even with very wet wounds, without the risk of skin and wound edge maceration.
- **Wound dressings with honey**
  Wound dressings impregnated with medical honey or honey plus a secondary dressing clean wounds and reduce odour. The osmotic effect of the honey in the wound and the low pH value creates a bactericidal effect.
- **Wound dressings with silver**
  There is a silver-coated version of almost every type of dressing. The basic requirement for the release of silver ions is a moist wound environment. These wound dressings are used on infected wounds and can reduce the colonisation of microorganisms.
- **Wound foils**
  The semipermeable transparent membranes made of polyurethane prevent the penetration of germs and moisture while allow water vapour to permeate, thus maintaining a moist wound climate.

Chapter 3: Debridement

3.1. Introduction and Definition:

EWMA document 2013 (WundManagement Special Edition 3/2013, page 4) explains the term debridement as the "removal of necrotic material, firm and viscous scab, serous crust, dead and infected tissue, hyperkeratosis, exfoliation, pus, haematoma, foreign bodies, detritus, bone splinters and other wound coverings of all kinds with the aim of promoting wound healing."

A wound must be cleaned in order to allow observation and healing!

The following procedures can be used individually or in combination:

- **Surgical debridement**
- **Mechanical debridement**
- **Biosurgical debridement (maggot or larval therapy)**
- **Autolytic debridement**
- **Enzymatic debridement**
- **Ultrasonic debridement**
- **Debridement using NPWT**

The aim of debridement is to ensure that the wound is monitored, to initiate the healing process and to prevent secondary infection of the remaining healthy tissue.

3.2 Surgical Debridement

Surgical debridement is an invasive method, which is carried out under local or general anaesthesia using tweezers and a scalpel, a ring curette, a water scalpel or a shaver. Scissors and sharp spoons should no longer be used as these two instruments squeeze the tissue, allowing germs to get deep into the tissue.

This invasive procedure is indeed the fastest and most effective method, but should still only be used if other methods do not work or are not sufficiently effective or the condition of the patient requires fast action and intervention.

Avital tissue structures (necroses, deposits) are removed, usually down to intact anatomical structures. It's often not possible to accurately select the tissue to be removed.

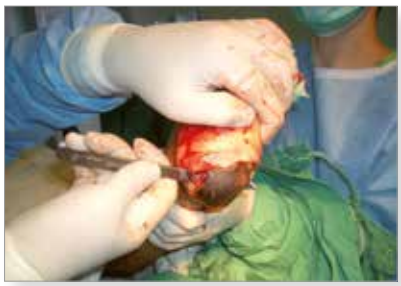


Fig. 3.2.2:
Surgical debridement with scalpel

Frequently, surgical debridement is also used to create a vital tissue bed for a subsequent skin graft.

Alternative methods should definitely be considered if the avital tissue is not too deep or the wound bed is covered with fibrin or viscous scabs.

The gentler debridement methods listed below can prevent excessive damage to the wound bed.

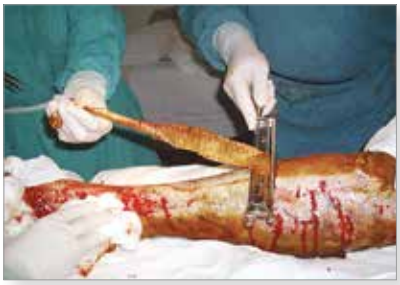


Fig. 3.2.1:
Surgical debridement with shaver

3.3 Mechanical Debridement

With mechanical debridement, the avital tissue areas (detritus, deposits, waste) are removed from the wound by wiping with sterile material that has been moistened with wound irrigation solution or antiseptic or with a pulsing stream of water.

The wiping can be painful for the patient and lead to trauma to the newly formed tissue (granulation and epithelial tissue). A gentler alternative for tissue would be the application of sterile, moist compresses on the wound. By applying slight pressure, some of the deposits will stick to the compress when it is removed. This needs repeating several times, each time with a fresh compress, which is correspondingly time-consuming (known as the wet-dry phase). The following products can be used for mechanical wound cleaning:

- **Debridement with dry gauze compresses:**
  More pain for the patient than with other materials.

- **Debridement with monofilament fibre pads:**
  Good results and relatively painless, detritus is removed without damaging the granulation tissue

.

- **Debridement with foamed PUR**

Fig. 3.3.1:
Mechanical debridement with LIGASANO® wound cleansing sponge intensive

(LIGASANO® Wundputzer®, schülke wound pads):
The cleaning sponges LIGASANO® Wundputzer® are multi-sided, achieve good results and are relatively painless. Depending on contact pressure, you can vary the wound cleaning intensity depending on the need and avoid damaging the newly formed granulation tissue.
The special structure of the foam means the deposits are not spread out. Instead, they are removed from the wound.

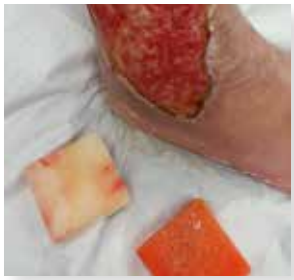


Fig. 3.3.1:
Mechanical debridement with LIGASANO® wound cleansing sponges medium and soft

There are three **abrasiveness levels**: **intensive, medium and soft**.

- **Debridement using jet lavage**:
  Biofilm, debris and foreign bodies are removed from the wound by rinsing with pressure. Depending on the strength of the pressure, loose materials or even dense connective tissue can be removed (= hydrosurgery). The procedure can be combined with antiseptic solutions (e.g. with polihexanide). Jet lavage systems are offered by several manufacturers with different techniques.

3.4 Biosurgical Debridement

A special form of mechanical debridement is the so-called maggot therapy (biological wound debridement with fly larvae, biosurgery). The fly larvae (genus Lucilia sericata, green bottle fly), which are bred under sterile conditions, help to remove stubborn necrosis. The maggots of this type of blowfly species are necrophages, i.e. they only eat dead tissue. The insects do not eat the necroses and deposits directly. Instead, they predigest them with a saliva they secret. The enzymes contained in the secretion liquefy the dead tissue, which is then consumed by the larvae as food.
The maggot secretion contains antibacterial substances and proteolytic enzymes, and stimulates the growth of the body's own fibroblasts and chondrocytes:

- **Gentle debridement of the wound**:
  The maggots feed on necrotic tissue and exudate and remove avital tissue from the wound (debridement) in this way. The digestive juices emitted by the larvae contain proteolytic enzymes, which debride the necrotic tissue and leave the living tissue intact („extracorporeal digestion").
- **Killing germs (especially gram-positive)**:
  The movement of the larvae stimulates the exudate, which allows better rinsing of the wound and flushing out of existing bacteria. The fly maggots neutralise the bacteria in their digestive tract. In addition, the larvae isolate secretions, which inhibits the bacterial activity.
- **Stimulation of the healing process**:
  Among other things, the larvae secretion contains alkaline components that change the pH of the wound and stimulate growth factors, improve oxygenation and thus promote wound healing.

Therapy with maggots has been carried out for 400 years, but lost its significance with the development of antibiotics and modern surgical techniques. This possibility of debridement has only been used more frequently in recent years because of antibiotic-resistant bacterial strains.
This therapy is very good for wounds with exposed bones and tendons, where surgical debridement would involve risks. However, it is also ideal for extensive soft tissue and bone infections, chronic skin ulcers (especially with DFU), pressure ulcers and ulcus cruris.
The wound must already be exuding to use this treatment. The maggots are either used loose as "free range" or in a polyester mesh bag. You use 2-8 free range maggots for each cm^2 of wound and fix them to the wound with a sterile mesh dressing. For most patients and also for specialists, the

Fig. 3.4.1:
BioMonde´s BioBag in use.

BioBag is the (mentally) more pleasant variant, since it prevents the maggots from escaping. 5-10 maggots are needed in the plastic bag for each cm^2 of wound area.
The free range maggots can produce better results for wounds on toes or skin creases, otherwise there is hardly any difference between free range maggots and BioBags. The maggots have to be changed after 3-4 days.
Contraindications are wounds near the eyes, in the upper gastrointestinal tract, and upper respiratory tracts. Maggots shouldn't be used in wounds with exposed blood vessels, which are connected with deeper internal organs, in patients with reduced blood flow or in malignant wounds. This form of therapy is also unsuitable for patients with known allergies to fly larvae, brewer's yeast or soy protein.
In general, debridement with medical maggots is a painless therapy. Nevertheless, pain can occasionally occur. It has not yet been satisfactorily resolved whether this pain is caused by the movements of the larvae in the wound bed or is down to change in pH value.

3.5 Autolytic Debridement

This so-called moist therapy, as the gentlest but most time-consuming form of debridement supports the body's self-cleaning process by supplying moisture. As a result, macrophages and other phagocytic cells are activated in the wound. Necrosis and deposits are softened and detach themselves from the wound bed (autolysis = self-dissolution).
The following product groups are suitable for autolytic debridement under certain conditions:

- **Hydrogels**
- **Hydroactive wound dressings / wet therapeutic agents**
- **Aquafibre dressings**
- **PUR foam dressing LIGASANO® white**

Please note the information provided by the manufacturer!

Fig. 3.5.1:
Autolytic debridement as part of wound treatment with LIGASANO® white

3.6 Enzymatic Debridement

Here, proteolytic enzymes (e.g. protease, streptokinase, streptodornase, fibrinolysin) are used as ointments or gels to dissolve necrotic tissue. This enzyme hydrolyses peptide bonds, thereby loosening necrosis or avital tissue more easily from the wound.
This method cannot be used with hard and dry necroses, as the enzymes only work in a moist wound environment. Debridement using proteolytic enzymes is only still rarely used, since the enzymes have to be applied once to twice a day to the tissue being debrided and this represents a significant amount of time.

3.7 Ultrasound Assisted Debridement

With ultrasound assisted wound debridement (UAW), low frequency ultrasound (LFUS) of 25 kHz is applied in combination with irrigation solution. The wound is flushed out with a rinsing liquid and treated with ultrasound. The ultrasonic pulse drives the introduced rinsing fluid into the deeper regions of the wound and loosens deposits and any loosely adhering necroses. Ultrasonic waves are generated by converting electrical energy into mechanical energy (reciprocal piezoelectric effect). The frequency, and thus the wavelength, has a major influence on the mode of action: high frequencies produce short waves, which penetrate less deeply; low frequencies, on the other hand, generate long waves with a greater penetration depth.
The debridement effect can be seen in mechanical effects as well as by cavitation (cyclically imploding gas bubbles). This is the formation of tiny bubbles in the rinsing liquid, which oscillate or implode. Especially due to this latter effect, implosion, microflows and pressure gradients are created, which also kill microorganisms.

Fig. 3.7.1:
Ultrasound debridement

Effects on the wound:
- Selective necrosectomy
- Reduction of microorganisms
- Effect of antibiotics and antimycotics is increased
- Increase in enzymatic endogenous fibrinolysis
- Increase in dermal microcirculation
- Promotion of granulation
- Stimulation of collagen synthesis

3.8 Debridement with NPWT (Negative Pressure Wound Therapy)

Treatment with negative pressure has been established for many years and offers many advantages:
- Removal of exudate from the wound
- Reduction of oedema
- Increase in local blood flow
- Reduction in wound size
- Promotion of angiogenesis and fibrogenesis
- Promotion of macrophage and leukocyte activity

Debridement using negative pressure wound therapy must not be performed on necrosis, infections, local ischaemia, acute bleeding and exposed vessels, tendons, bones, etc.
For NPWT with LIGASANO® see chapter 4.7 on page 65-72

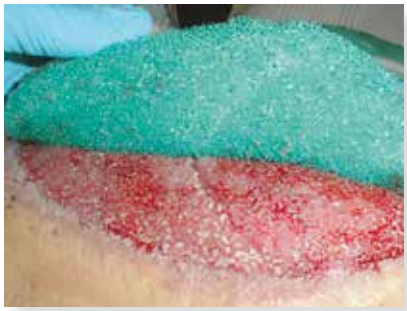


Fig. 3.8.1:
Debridement using NPWT with LIGASANO® green

Chapter 4: Modern Wound Treatment with Middle to Rough Pored PUR Foam Dressing (LIGASANO®)

4.1 Mode of Action of the PUR Foam Dressings LIGASANO® white, LIGASANO® orange and LIGASANO® green

LIGASANO® white, LIGASANO® orange and LIGASANO® green are polyurethane foams of the newest generation. The origins of polyurethane date from the middle of the past century. The basic chemical reaction was developed by the chemist Würtz already in 1848. But the importance of this chemical process was recognised considerably later and taken up in 1937 by Otto Bayer in Leverkusen/Germany. Because of his single-minded research it was possible to launch first the polyester rigid foam, later the polyester soft foam and after 20 years of work the polyether foam. These plastics obtained the collective name polyurethane (PUR) and were developed to the most universal material at all.

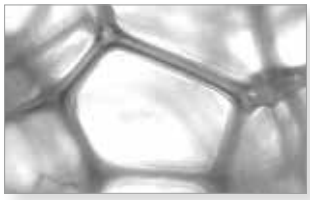
Source: Association of the polyurethane soft foam industry

In cooperation with Prof. Dr. med. Gerhard Weber (MD), at that time head physician of the dermal department of the Clinical Centre Nürnberg/Germany, a polyurethane foam for the medical application was created and named LIGASANO®. This term without further supplement refers to the product that is known today by the term "LIGASANO® white". The additional expression "white" refers to the colour of the product and became necessary because another polyurethane material, further named "Green Climate Grid®" is now available by the term "LIGASANO® green". The impulse of developing LIGASANO® green came, just as in the case of LIGASANO® white, from the medical and nursing practice. To produce a complete healing of pressure ulcers it is absolutely essential to effect a release of pressure in the wound, apart from the local wound treatment. As described in an article of the specialists periodical "Deutsches Ärzteblatt" from 1980 (page 1621-1625) by Gerhard Weber and Karl-Heinz Galli, LIGASANO® white as well accomplishes this task with excellent results.

4.1.1 LIGASANO® white

LIGASANO® white is a therapeutically effective polyurethane foam material with a wide range of application for wound cleaning, wound treatment and recurrence prophylaxis or prevention. LIGASANO® white is a mixed-pored material, this mean it has open, semi-open and closed pores.
It must always be applied by a physician or medically trained personnel.
The therapeutic use is based essentially on **three underlying principles**:

- **Rapidly falling pressure tension**
- **Mechanical stimulus**
- **Controlled absorption effect (exudate management)**



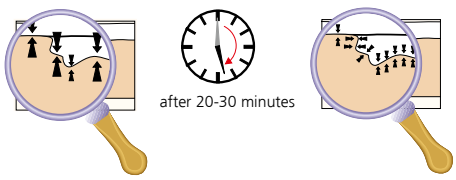
There are various types of polyurethane foams, which are not comparable with each other. The physical effects mentioned above, result in the unique therapeutic benefit of LIGASANO® white, and is not comparable with other, e.g. microporous polyurethane foams. Even confusingly similar looking, mixed-pored PUR foams with medium and large pore sizes, do not have the same effect.
If you want to use LIGASANO® white, just ask yourself the following questions:

- Is a local promotion of blood circulation preferable?
- Do you think that a quick and atraumatic wound dressing change, without significant disorder of the wound, favours wound healing?
- Is it expedient that no (additional) agents are needed in the wound and that an additional wound cleaning is usually not necessary?

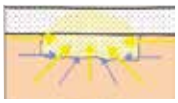
These effects are always simultaneously maintained and promoted respectively by LIGASANO® white.

Rapidly falling pressure tension:

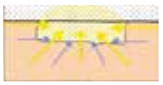
By its rapidly falling pressure tension LIGASANO® white adapts to contours with minimised pressure. This results in an even and minimised pressure on wound and body. Additionally the attachment of collagene is promoted by the pressure reduction on the wound surface.
The overlay pressure of the body of bedridden immobile patients is distributed very evenly by LIGASANO® white. The formation of ischaemic decubital ulcers is effectively prevented.

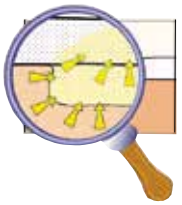


Mechanical stimulus:
LIGASANO® white promotes blood supply in contact to wound and skin, thus improving the supply with nutrients and oxygen of the wound area (activation of the wound) and acts preventively on intact skin. Stimulates normal bodily functions at local level, especially in the case of inactive patients or where these functions are reduced. The mechanical stimulus lasts up to three days by which time LIGASANO® white should then have been changed. Even without concious movements, the surface structure of LIGASANO® white develops a mechanical stimulus. Due to contact with wound or skin the blood flow is stimulated, with all positive consequences. By activation of the self-cleaning it comes to improved secretion (more exudate = antiseptic effect), coatings and germs are flushed out and absorbed, with the simplest of means and without chemistry. The effect is an autolytic debridement and wound conditioning, that can be assisted manually if needed. Micro and macro motions of the patient cause an intermittent negative pressure and this promotes a mechanical stimulus on wound and skin.



Controlled absorption effect (exudate management):
Absorbs surplus exudate without a drying-out effect. A moist and warm wound environment is formed, germs are reduced, the wound is cleaned. LIGASANO® white does not stick to the wound and prevents maceration of the surrounding skin. This PUR foam dressing has a high suction volume without change of its dimensions and without induration. LIGASANO® white has a high absorptive effect due to its honeycomb inner structure without drying-out effect. Surplus exudate and body moisture is absorbed, thus preventing a maceration of wound and sorrounding skin. The risk of bacterial colonisation is reduced.





LIGASANO® white can reduce significantly the risk of wounds as a result of poor blood circulation. Wound healing disorders due to poor blood circulation may be reduced or removed, and infected wounds are cleaned, largely without the need for any further action. Thus it stimulates granulation and epithelisation and the desired results mostly occur quickly and clearly. LIGASANO® white is not an implant, and must therefore not remain permanently in wounds. After a maximum of 3 days contact with the wound the LIGASANO® white padding of the wound surface and/or padding inserted into the wound must be changed.

Intended Use:
Promotion of wound healing in sterile application by cleaning, filling or covering wounds or in non-sterile application as a secondary dressing (without direct wound contact) in wound treatment or in concomitant wound treatment, e.g. for pressure relief, or preventively as pressure and friction prevention.

Indications:
Acute and chronic wounds (e.g. decubital ulcers, ulcus cruris, diabetic foot ulcers. Post-surgical wounds and post-surgical wound healing impairments. Thermal wounds, such as burns, scalds, frostbite.

Contraindications:
Tumour wounds and untreated osteomyelitis. Not suitable for contact with organs, contact to exposed blood vessels with the danger of damage, or contact with nerves.

Application:
LIGASANO® white sterile must not continuously remain in the wound or in the body. The application may be repeated over a period up to 12 months, always with a new dressing. Dressing change after 1-3 days, depending upon the indication. Please consider that LIGASANO® white sterile must not have direct contact to organs. It may have direct contact to mucosa.
Any applications in contact, connection or combination with any additional preparations, drugs, solutions, ointments, etc. are not guaranteed by us. Applications in combination with additional mechanical, electrical or electronical apparatuses or aids are not guaranteed by us.
Please read the instructions for use carefully before use. The instructions for use are enclosed with each original pack.

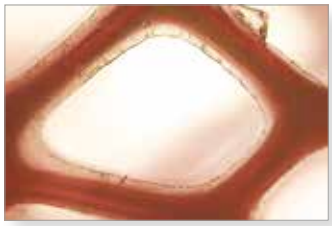
Patients with chronic wounds have a higher need of energy, proteines, zinc, vitamines and liquid. Please use our calculation sheet on page 105 or make use of our download-offer at **www.ligasano.com/downloads.**

Here a short review in table form of the significant modes of action of LIGASANO® white:

	Wound treatment	Prevention
Rapidly falling pressure tension	Reduction of pressure, promotion of granulation, reduced counter pressure on the new regenerated granulation tissue.	Anatomic adaption to body contours.
Mechanical stimulus	Because of its surface structure (the structure of the material is perceived by the tissue) LIGASANO® white promotes the perfusion and activates the self-cleaning ("hydrogel, produced naturally in the body"). The intermittent negative pressure, which is caused by the pumping effect in connection with conscious and unconscious body movements, produces a mechanical stimulus, too.	Because of its surface structure (the structure of the material is perceived by the tissue) LIGASANO® white promotes the perfusion, non-vital dermal skin cells are removed automatically.
Controlled absorption effect	Since only surplus exudate is absorbed, LIGASANO® white does not dry out the wound. Depending on the thickness of the material, an intermittent negative pressure occurs.	Works effectively against maceration of the skin.
Permeability to steam	In case of hardly exudating wounds, LIGASANO® white may adhere by drying up exudate. At burns this is sometimes desired (mechanical debridement).	Works effectively against maceration of the skin.
!!!	For wound treatment the thickness of LIGASANO® white has to be always at least two centimetre (measured from the wound ground), to reduce the permeability to steam and to assure enough temperature insulation. You get the required thickness by putting LIGASANO® white one upon the other.	

4.1.2 LIGASANO® orange

LIGASANO® orange is an elastic, expanded polyurethane (PUR), which is almost always pervious to air and liquids (e.g. water) - imagine a three-dimensional sieve. It has a coarse texture and rough surface.
LIGASANO® orange is used for wound treatment and care, if a strength and elastic material with high permeability to air and liquid is required. It must always be applied by medic or medically trained personnel.



LIGASANO® orange is a very simple product, the effect of which results in its structure. It contains no agents and does not emit such either. The effect resp. the intended effect is little complex - quite the contrary very easy and with general knowledge well comprehensible.
At intended use the risks are marginal. A mechanical overstraining in the contact area of wound or skin is well predictable with the naked eye, and due to the anyway required medical care, the preparation may removed in time, if necessary, before any injury occurs. The effect is pure physical and stops virtually promptly after removal of the preparation.

Intended Use:
Promotion of wound healing in sterile application by cleaning, filling or covering wounds or in non-sterile application as a secondary dressing (without direct wound contact) in wound treatment or in concomitant wound treatment, e.g. for pressure relief, or preventively as pressure and friction prevention.

Indications:
Acute and chronic wounds (e.g. decubital ulcers, ulcus cruris, diabetic foot ulcers. Post-surgical wounds and post-surgical wound healing impairments. Thermal wounds, such as burns, scalds, frostbite.

Contraindications:
Tumour wounds and untreated osteomyelitis. Not suitable for contact with organs, contact to exposed blood vessels or anastonomic areas with the danger of damage, or contact with nerves.

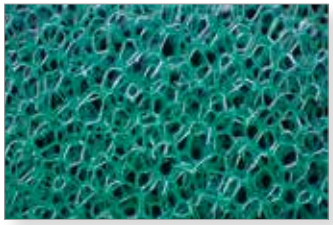
Application:
LIGASANO® orange sterile must not continuously remain in the wound or in the body. The application may be repeated over a period up to 30 days, always with a new dressing. Dressing change after 1-4 days, depending upon the indication. Please consider that LIGASANO® orange sterile must not have direct contact to organs, exposed blood vessels and anstonomic areas. It may have direct contact to mucosa.
Any applications in contact, connection or combination with any additional preparations, drugs, solutions, ointments, etc. are not guaranteed by us. Applications in combination with additional mechanical, electrical or electronical apparatuses or aids are not guaranteed by us.
Please read the instructions for use carefully before use. The instructions for use are enclosed with each original pack.

Here a short review in table form of the significant modes of action of LIGASANO® orange:

	Wound treatment	Prevention
Mechanical stimulus	Because of its surface structure (the structure of the material is perceived by the tissue) LIGASANO® orange promotes the perfusion and activates the self-cleaning ("hydrogel, produced naturally in the body").	The surface of LIGASANO® orange is relatively rough. If it is used in wounds or on skin, lesions may occur, especially by friction.
Sorption effect	Due to its open-pored structure LIGASANO® orange has no sorption effect. This means you need a suction source for an active wound drainage or NPWT. By its open-pored and relatively large-pored structure you can drainage even viscous exudate and detritus very well.	Works effectively against maceration of the skin.
Permeability to steam	Nearly completely permeable. Thus exudate may dry out, if the wound only exudates weakly and LIGASANO® orange may stick.	Works effectively against maceration of the skin.

4.1.3 LIGASANO® green

LIGASANO® green is an elastic, expanded polyurethane (PUR), which is almost always pervious to air and liquids (e.g. water) - imagine a three-dimensional sieve. It has a coarse texture and rough surface.
LIGASANO® green is used for wound treatment and care, if a strength and elastic material with high permeability to air and liquid is required. It must always be applied by medic or medically trained personnel.



LIGASANO® green is a very simple product, the effect of which results in its structure. It contains no agents and does not emit such either. The effect resp. the intended effect is little complex - quite the contrary very easy and with general knowledge well comprehensible.
At intended use the risks are marginal. A mechanical overstraining in the contact area of wound or skin is well predictable with the naked eye, and due to the anyway required medical care, the preparation may removed in time, if necessary, before any injury occurs. The effect is pure physical and stops virtually promptly after removal of the preparation.

Intended Use:
Promotion of wound healing in sterile application by cleaning, filling or covering wounds or in non-sterile application as a secondary dressing (without direct wound contact) in wound treatment or in concomitant wound treatment, e.g. for pressure relief, or preventively as pressure and friction prevention.

Indications:
Acute and chronic wounds (e.g. pressure ulcers, ulcus cruris, diabetic foot ulcers. Post-surgical wounds and post-surgical wound healing impairments. Thermal wounds, such as burns, scalds, frostbite.

Contraindications:
Tumour wounds and untreated osteomyelitis. Not suitable for contact with organs, contact to exposed blood vessels or anastonomic areas with the danger of damage, or contact with nerves.

Application:
LIGASANO® green sterile must not continuously remain in the wound or in the body. The application may be repeated over a period up to 30 days, always with a new dressing. Dressing change after 1-4 days, depending upon the indication. Please consider that LIGASANO® green sterile must not have direct contact to organs, exposed blood vessels and anstonomic areas. It may have direct contact to mucosa.
Any applications in contact, connection or combination with any additional preparations, drugs, solutions, ointments, etc. are not guaranteed by us. Applications in combination with additional mechanical, electrical or electronical apparatuses or aids are not guaranteed by us.
Please read the instructions for use carefully before use. The instructions for use are enclosed with each original pack.

Here a short review in table form of the significant modes of action of LIGASANO® green:

	Wound treatment	Prevention
Mechanical stimulus	Because of its surface structure (the structure of the material is perceived by the tissue) LIGASANO® green promotes the perfusion and activates the self-cleaning ("hydrogel, produced naturally in the body").	**Skin contact not recommended!** The surface of LIGASANO® green is relatively rough. If it is used in wounds or on skin, lesions may occur, especially by friction.
Sorption effect	Due to its open-pored structure LIGASANO® green has no sorption effect. This means you need a suction source for an active wound drainage or NPWT. By its open-pored and relatively large-pored structure you can drainage even viscous exudate and detritus very well.	**Skin contact not recommended!** Works effectively against maceration of the skin.
Permeability to steam	Nearly completely permeable. Thus exudate may dry out, if the wound only exudates weakly and LIGASANO® green may stick.	**Skin contact not recommended!** Works effectively against maceration of the skin.

4.1.4 Technical Information

All LIGASANO® products are physiologically harmless and hypo-allergenic, to our knowledge and at the time of printing. LIGASANO® **does not contain** e.g. phthalate, lead, additives such as latex, optical brighteners, flame inhibitor, softeners, halogenes, silicone oils etc.

The protection of people and the environment is of particular importance to us and a central guideline during the production process. And that over the entire life cycle of the products to disposal!

Technical data	LIGASANO® white	LIGASANO® orange	LIGASANO® green
Material basis	Polyurethane expanded	Polyurethane expanded	Polyurethane expanded
Cell structure	Mixed-pored, comparatively macro-pored polyurethane foam, cell type 750	Open-pored, macropored cell grid with removed cell membranes, cell type 850	Open-pored, very macropored cell grid with removed cell membranes, cell type 1500
Absorptivity	Controlled absorptive	Permeable to liquids like a sieve	Permeable to liquids like a sieve
Breathability	Breathable, limited permeable to air	Nearly completely permeable to air	Nearly completely permeable to air
Permeability to steam	Very high permeability	Nearly unhindered permeability	Nearly unhindered permeability
Pressure tension	Rapidly falling, ca. 40% after 20 minutes	Less falling	Less falling
Adaption to shapes	Adapts to shapes with low pressure (moulding)	Permanent elastic, low decrease in pressure	Permanent elastic, low decrease in pressure
Mechanical stimulus, promotion of local blood circulation	Effective stimulation of blood flow, thereby scarcely a risk for normal and sensitive skin; at the beginning formication, after 15-20 minutes neutral.	Medium strong mechanical stimulus; because of the relatively rough surface, skin contact could be felt as uncomfortable; risk of lesions in the case of friction. Please note the possible combination with LIGASANO® white.	Intensive mechanical stimulus; because of the rough surface, skin contact is mostly felt as uncomfortable; increased risk of lesions in the case of friction. Please note the possible combination with LIGASANO® white.
Allergies	Completely hypoallergenic	Completely hypoallergenic	Completely hypoallergenic
Durability	The mechanical stimulus is lost after three days of application, the material becomes deformed permanently.	Depending on the load, up to several weeks.	Depending on the load, up to several weeks.
Storage / Shelf life	Dry and protected from light in the original package; unopened stable up to 36 month after date of manufacture.	Dry and protected from light in the original package; unopened stable up to 60 month after date of manufacture.	Dry and protected from light in the original package; unopened stable up to 60 month after date of manufacture.
Sterilisation	Sterilisation on site and subsequent application of the thus sterilised products for wound treatment: The non-sterile product can be sterilised at 134 °C for five minutes with moist heat according to a validated procedure. These standardised parameters meet the requirements for adequate product safety and economy and there are no measurable effects on the properties of LIGASANO®. In case of sterilisation of non-sterile LIGASANO® products on site (e.g. in the clinic, practice etc.) the legal regulations and risks have to be observed. In particular, we would like to point out that in the event of excessive contamination (>200 CFU), the sterilised product could be contaminated with an excessive, risk-increasing amount of pathogenic germs. In case of sterilisation or re-sterilisation you act on your own responsibility. Please also note that the intended use, indication, adverse effects, contraindication, performance characteristics and application change if you use the locally sterilised product for wound treatment.			

4.2 Expert Standard "Care of People with Chronic Wounds"

The expert standard „Care of People with Chronic Wounds" defines chronic wounds as follows: "wounds are characterised `chronic`, if they show no tendency to heal during 4-12 weeks after development of the wound, despite consistent therapy. There are many reasons and types of chronic wounds, whereupon the present expert standard refers to wounds of the type decubitus, diabetic foot ulceration and ulcus cruris (venosum, arteriosum, mixtum). These are the most common chronic wounds, by which nursing stuff are faced with.
All in all ca. 4 mio. people are concerned in Germany. By the demograhic trend we have to calculate with a distinctly increasing number, because the concerned patients are primary elder people with diabetes mellitus and/or vascular caused diseases. For the treatment of chronic wounds we have to calculate, according to BVMed, with an annual amount between 2 and 4 billion Euro.

Objective of the expert standard "care of people with chronic wounds":
"Every patient/resident with a chronic wound of type decubitus, ulcus cruris venosum/arteriorum/mixtum or diabetic foot ulceration obtains nursing supply, that supports the individual understanding of the disease, promotes quality of life, supports the wound healing and avoids a recurrence of the wounds.
Reason: chronic wounds are often symptoms of a chronic disease, that affects the daily life of the persons concerned. Chronic wounds lead to considerable disturbance of life quality, especially by pain, limitation of mobility, exudate and odour. Through guidance and consultation of the patient/resident and their family in measures for everyday life in wound handling and in the wound-caused and therapy-caused impacts, the abilities for health-related self-management may improve in a way, that positive effects for wound healing and life quality arise. In addition, appropriate assessment, phase-adapted wound treatment as well as continuous documentation of the process, taking into account the patients/residents illness, improve the chance for healing."
In few sentences is summarised what wound experts already had known: the chronic wound often has a negative effect on the patient´s quality of life. This in turn often leads to delayed wound healing and even worse quality of life. It is important to break this vicious circle by promoting the patient´s quality of life:

- **Reduction of pain**: the doctor or specialist doctor is responsible for the pain therapy, that is appropriate to the patients´ needs. But also the patient, the nursing stuff and the relatives are implicated, to assess the efficiency of the pain therapy. The use of low-pain wound dressings and appropriate procedures for dressing changes play a role, too.
- **Promotion of mobility**: nurses and employees of health care supply stores are in demand, to gather the patients´ needs and to supply the patient with adequate aids. The payer (e.g. medical insurance) also plays an important role, because a prompt supply with individual adapted aids is only possible in cooperation with medical insurance and / or nursing care insurance.

Because wound treatment is a multi professional task, several other professional groups are important for patients with a chronic wound:

- **Hospital and / or specialist clinic**, with several diagnostic (e.g. complex vascular examination) and therapeutic (operation, re-vascularisation, mesh graft transplantation, amputation) possibilities.
- The **specialist doctor**, which sees the patient in longer intervals: he/she supplies the family doctor in the therapy of the patient.
- The **medical assistants** of the doctors and specialist doctors: they assist the doctor in the patients´ therapy respectively therapeutic decision.
- The **podiatrist**, which cares for the foot health.
- The **wound expert** of a medical device manufacturer or homecare company, which cares for the wound treatment with modern phase-adapted dressings. She/he controls the treatment, together with doctors, nursing service and the patient.
- The **nursing care service** with nursing specialists and wound experts. A nursing care service cares for outpatients, as directed by the physicians, to ensure the current documentation, and informs the other members of the therapeutic team in case of abnormalities and changes. In inpatient care facilities, this is valid analogically for the local specialist nursing staff.
- The **medical service of health insurance** is a consulting institution for health insurances and persons concerned.

- Not forgetting the **relatives** of the patient, which are supporters, facilitators, evaluators and partly user of the wound care.

Such a network should be around every patient with chronic wounds, the members of the network should communicate and at best cooperate with each other. Details to living networking and many standards and information around the topic "chronic wounds", please find at the website of the wound center Hamburg e.V. **http://www.wundzentrum-hamburg.de**.
The expert working group of the expert standard calls the recurrence prophylaxis an important element in all patients with chronic wounds. They recommend the following measures, cited below:

- In case of **decubital ulcerations**: pressure distribution by means of position change, promotion of physical activity, promotion of micro movements, use of pressure-distributing aids, maintenance and promotion of tissue tolerance by appropriate skin care and nutrition, which is adapted to the patients´ needs.
- In case of **diabetic foot ulcerations**: careful choice of footwear and wearing behaviour, continuous inspection of feet and shoes, avoidance of hurts, nutrition counseling, weight reduction, visit to the doctor also in case of small injuries
- In case of **ulcus cruris venosum** (leg ulcer): lifelong wearing of compression stockings or bandages, skin care, no self-medication with prescription-free vein drugs, avoidance of injuries, visit to the doctor also in case of small injuries, physical exercises and walking, elevation of the legs above heart level, weight reduction
- In case of **ulcus cruris arteriosum**: giving up smoking, weight reduction, a diet low in cholesterol, optimisation of blood pressure, physical training, intake of drugs.

Table of the standard criteria of the expert standard "Care of people with chronic wounds":

Structural criteria	Process criteria	Result criteria
S1a - The **care specialist** has actual knowledge and communicative skills to identify persons with chronic wounds and to explore their limitations, understanding of illness and self-management abilities in a sensible and understanding way. **S1b** - The **care facility** has an intra- and interprofessional procedural rule for the care of persons with chronic wounds. This procedure ensures that an nursing care specialist is available and materials for assessment and documentation are kept ready.	**P1a** - Under custodial anamnesis, the **care specialist** determines the understanding of illness, wound caused and therapy caused restrictions of all patients which have a chronic wound, as well as possibilities of health-related self-management. **P1b** - The **care specialist** obtains a medical diagnosis. For the wound-specific assessment, the qualified nurse calls a custodial expert, especially for the first evaluation and wound documentation, and involves the expert in the further treatment as required.	**R1** The documentation contains differentiated information in the following points: - limitations in mobility and other restrictions, pain, wound odor, exudate, nutritional status, mental health, disturbance of body image, fears - knowledge of the patient/inhabitant and her/his family members about causes and healing of the wound as well as competences in self-management - specific medical wound diagnosis, number of relapses, duration, localisation, size, border, surroundings, wound ground and inflammatory signs
S2 - The **care specialist** has actual knowledge in the treatment of wound-based restrictions, in ailment-specific measures according to the type of wound (e.g. promotion of exercises, pressure relief or compression), in wound treatment, in basic diseases and in prevention of recurrency and infection, as well as skin protection.	**P2** - The **care specialist** plans together with the patient/inhabitant and her/his family members and the involved professional guilds measures in the following areas: wound caused and therapy caused impairments, wound-specific demands, underlying disease and relapse prophylaxis, prevention of further damages, implementation of medical prescriptions.	**R2** An individual action plan is existent, oriented in daily routine, that respects the health-related self-management competences of the patient/inhabitant and her/his family members.
S3a - The **care specialist** has competence in regulation and implementation relating to the care of people with chronic wounds. **S3b** - The **care facility** ensures, that prescribed auxiliary aids and dressings are provided promptly and that materials for a hygienic dressing change are available. It arranges the appropriate personnel planning. It ensures an adequate personnel planning for the complexe requirements.	**P3a** - The **care specialist** coordinates inter- and intraprofessional care (e.g. by physicians, custodial experts, physiotherapist, podiatrist and certified diabetes educator). **P3b** - The **care specialist** ensures hygienic and professional wound treatment as well as the continuous implementation of the action plan together with the patient/inhabitant and her/his family members.	**R3** the coordinated measures are realised properly and professionally. Its implementation and effect are continuously documented. The patient/inhabitant and her/his family members experience the active involvement in the treatment in a positive way.
S4a - The **care specialist** has actual knowledge and competence in information, guidance, instruction and tutorial for health-related self-management. **S4b** - The **care facility** provides materials for information, guidance, instruction and tutorial for specific target groups.	**P4** - The **care specialist** instructs in wound causes and promotes the skills of the patient/inhabitant and his/her family members in wound treatment as well as in handling the wound-caused and therapy-caused limitations by methods of patient education. The qualified nurse supports the contact to other professional guilds, support groups or other health groups.	**R4** the patient/inhabitant and his/her family members know the cause of the wound as well as the importance of the arranged measures, and they are informed in further support possibilities. Their health-related self-management is promoted due to their individual possibilities.

S5 - The **care specialist** has the competence to assess the healing process of the wound and the effectiveness of the measures.	**P5a** - The **care specialist** evaluates in individual specified intervals, not later than after four weeks, the local wound situation (repetition of the wound assessment). **P5b** - The **care specialist** evaluates, together with a custodial expert at the latest all four weeks the effectiveness of the whole measures and makes modifications, if applicable, in agreement with the patient and all involved persons.	**R5** Indications of improvement of the wound situation and the impairment of life-quality caused by the wound are on hand. Changes in the action plan are documented.

Table translated from: Deutsches Netzwerk für Qualitätsentwicklung in der Pflege (German Network for Quality Development in Nursing) (Ed.): Expertenstandard Pflege von Menschen mit chronischen Wunden, 1st update, September 2015

4.3 Documentation and Description of Wounds

A wound documentation is mandatory and it is arranged within the wound management. As an instrument of quality assurance and control, the progress, stagnation and rebounds in the treatment are assessed and understood, as well as measures of treatment and therapies can be adapted. The documentation assures the information flow between physicians and nurses and may avoid, that the next shift takes complete other measures only because an other nurse treats the wound. The documentation and accordingly the treatment of the wound is also a confirmation of the realisation of required measures (legal liability hedging).
The wound documentation must be recorded in writing (paper or electronic), it must be dated and signed, meaningful and comprehensible, and if possible provided with a wound picture.

What has to be documented?

- **Name, first name and date of birth of the patient**
- **Type of wound and wound aetiology:**
  Diagnosis is the responsibility of the physician.
- **Date and place of origin:**
  Immediate inspection after admission and re-admission respectively, immediate documentation, possibly with picture(s), information to superiors and the attending physician with documentation.
- **Localisation of the wound:**
  Use schematic description and only one wound per document.
- **Wound duration:**
  This is the time from the development of the wound to the actual assessment.
- **Number of recurrences:**
  Multiple recurrences can be a symptome for insufficient treatment of the underlying disease. You have to quote the recurrences and the intermediary time free of recurrences.
- **Wound dimensions:**
  The size of the wound is described by the parameter form, length, width, circumference, depth, volume, area and undermining/channel. There are different measuring methods, e.g. ruler method, tracing with mechanical or digital planimetry, etc.
  At the recording of the diameter with the ruler you have to measure the greatest distance of the wound edges, both vertical (length, head-feet-axis) and horizontal (width), in doing so the axes have to be perpendicular. In case of pockets, fistulae und underminings, their length and direction is specified (according to timepiece way).
  At the tracing resp. the planimetric recording the wound dimension is determined by retracing on a sterile rasterised wound foil (with small boxes 1cm² in size) and following counting of the small boxes. The planimetric recording is also possible computer-based by special software.
  The depth of the wound and potential underminings are recorded with a sterile measuring searcher.
  Specific characteristics in the wound have to be localised by means of a clock and in case of a photographic documentation the position noted e.g. "12:00 o´clock".

- **Wound base:**
  The wound base is assessed always after wound cleaning. You have to specify the tissue type (granulation tissue, fibrin, wet or dry avital tissue, dermis, fat tissue, muscle, fascia, tendon, bone) and the quantity regarding the wound area.

- **Wound edges and wound environment:**
  Skin changes, such as maceration, signs of inflammation, oedemas, etc. have to be documented necessarily. The property of wound edges can be described with "well defined", "perforated", "diffuse", "irregular", "cliffy", "edged" and "involute". Further criteria are "healed", "more than 50% of the wound edge is epithelised", "less than 50% of the wound edge is epithelised", "adherent", "no epithelisation", "not adherent", "undermined", "vital", "non-vital".
  Evidence to infections are deviated and documented in dependence on systemic classical infection signs.

- **Wound odour:**
  The expert standard recommends, only to state whether an odour exists or not and not to describe it, because this is a subjective appraisal.

- **Exsudate:**
  The exudate is described according to type (quality) and to amount (quantity):
  Quality:
  • serous/sanguineous: diluted, bright, red to pink
  • serous: diluted, lucid, bright, yellowish
  • serous/suppurative: opaque
  • suppurative: opaque, yellowish to green with putrid/bad odour
  Quantity (subject to space of time of the last dressing change):
  • no: healed or dry wound
  • marginal: wound bed moist, dressing dry
  • little: wound bed moist, dressing only sparse moist
  • moderate: considerably liquid in the wound bed and > 50% of the dressing soaked
  • plenty/large quantity: the dressing is more than exhausted

- **Wound healing phases:**
  (• Haemostasis)
  • Exudation phase
  • Granulation phase
  • Epithelisation phase
  (• Remodelling)

- **Signs of infection:**
  Dolor (pain) - calor (warmth) - tumor (swelling) - rubor (erythema) - functio laesa (functional limitation)
  Local and temporal limited infection signs are normal during exudation phase.

- **Used products:**
  Solutions for disinfection and irrigation, skin protection, primary dressing, secondary dressing (covering) if applicable, fixation.

- **Photo documentation:**
  The documentation with pictures visualises the wound description and should be made always after wound cleaning. Pay attention to the same lighting conditions, the same distance (ca. 30 cm) and the same angle. Take the photo preferably without flash. The wound should seize one third of the picture and the body area should be recognisable. Preserve anonymity and privacy. Stick the wound ruler in two dimensions.
  Before every photo documentation ask the patient for a written declaration of consent.

- **Remonstration:**
  Strictly raise an objection in case of therapy orders, that trespass against current treatment standards. Initially ask the prescriber in a friendly way, afterwards in written form or via fax. Note this in the nursing or wound documentation and inform your superior.

The written evaluation of the wound should take place after every dressing change, but at the latest after one week.

4.4 Wound Cleansing and Mechanical Debridement with LIGASANO®

Debridement is a key component of wound treatment with the aim of the preparation of best possible conditions both in the wound and in the wound edges (see also chapter 3). The purpose of debridement is the promotion and / or acceleration of wound healing. According to the EWMA document 2013 "Debridement", the indication for debridement and the choice of the method conforms less to the diagnostic of the wound, than rather to the typification of the tissue, which covers the wound, as well as its moisture degree and the patient´s situation.
If you use LIGASANO® white as a wound dressing, it effects a mechanical wound debridement, too. But persistant coatings can be loosened much more efficiently with LIGASANO® green and LIGASANO® orange.
These cleansing pads are qualified for mechanical debridement of all types of wounds and all wound phases. They are available in three different intensities. Depending on the pressure you can strengthen the intensity additionally. You can treat the wound as well as the wound edges.
LIGASANO® wound cleansing sponges are usable from all sides and thus especially economic. If required, in case of infected wounds, it is possible to moisten all LIGASANO® products with polihexanid solution. By their elasticity, the LIGASANO® wound cleansing sponges adapt to the wound surface.
A clean wound is a precondition for wound healing and wound documentation!

4.4.1 LIGASANO® Wound Cleansing Sponges Standard

LIGASANO® wound cleansing sponge intensive
Removes very persistant, viscous, firm and / or necrotic coatings, may absorb a lot of detritus.

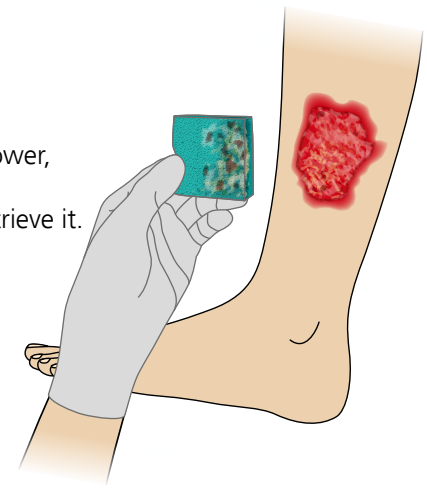
LIGASANO® wound cleansing sponge medium
Removes viscous, firm and / or necrotic coatings, may absorb plenty of detritus.

LIGASANO® wound cleansing sponge soft
Removes soft coatings and biofilm.

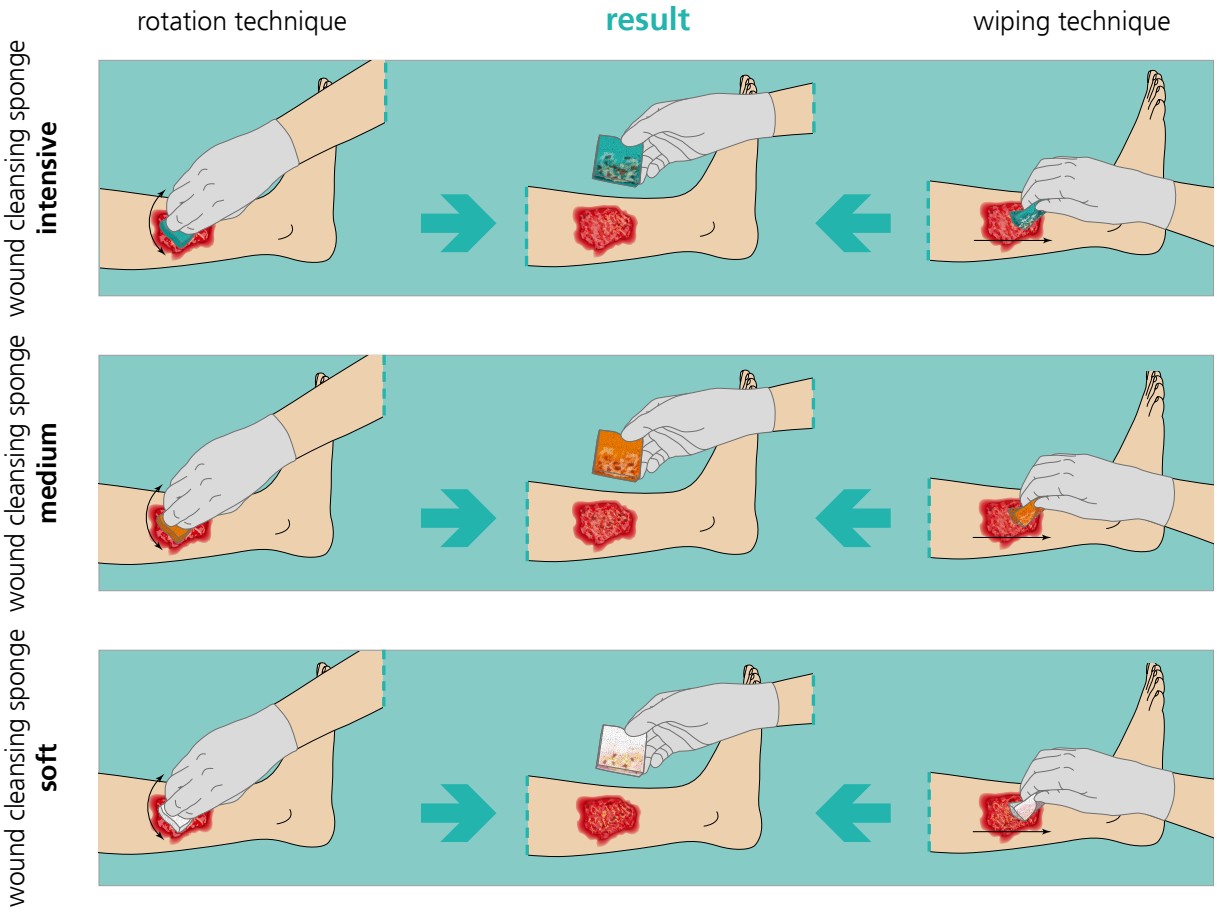
For every kind and amount of coating we have the appropriate wound cleansing sponge. Except for dry necrosis, which are normally removed by scalpel or alternatively they are soaked before.
Please find a recommended assortment in the adjacent table.

Kind and amount of coatings	much	mid	little
persistant	●	● / ●	● / ●
viscous	● / ●	● / ●	● / ●
soft	●	● / ○	○

- **Easy application**:
  The size 5 x 5 x 2 cm fits comfortably in the hand.
- **Effective & economic**:
  You can vary the intensity of the wound cleansing effect with the pressure power, adjusted to the need of your patient. Because of its structure, the LIGASANO® wound cleansing sponge does not disperse the coatings in the wound but retrieve it.
- **Hygienic**:
  Either three pieces in one peel-pack (1x green, 1x orange, 1x white) or single packed. Thus you can clean the wound from the coated surface to the bottom always with a fresh LIGASANO® wound cleansing sponge. The LIGASANO® wound cleansing sponges are useable multilateral.



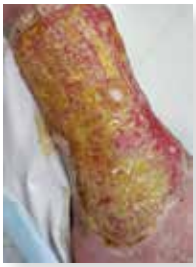
How to apply LIGASANO® Wound Cleansing Sponges:

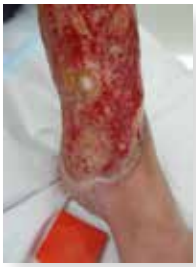


Please note: mechanical debridement **may cause** pain, even with the LIGASANO® wound cleansing sponge! Please pay attention to sufficient analgesia, if necessary. A moistening with wound irrigation solution can make sense. In the case of patients during a therapy with anticoagulants (e.g. Marcumar® or acetylsalicylic acid) an appropriate risk assessment has to be made. The wound treatment with LIGASANO® has to be made by physicians or medically trained personnel.

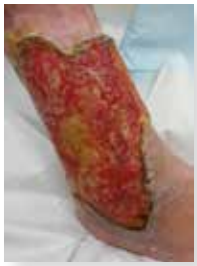
Case 1:
90 years old, female, diabetes mellitus, obesity, incontinence, bed-ridden; wound cleaning with LIGASANO® wound cleansing sponge intensive; wound dressing LIGASANO® white

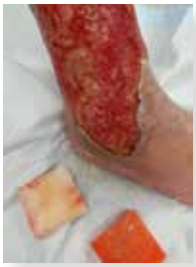
Case 2:
36 years old, female, PAD stage 2, addicted to heroin, necrosis on both lower legs (injection sites), wound debridement with LIGASANO® wound cleansing sponges medium and soft.





Left lower leg, condition before and after cleaning with LIGASANO® wound cleansing sponge medium: fibrin and biofilm are removed.





Right lower leg, condition before and after cleaning with LIGASANO® wound cleansing sponge medium and soft: distinct removal of the fibrin coatings; wound edges with necrosis are visibly cleaned.

4.4.2 LIGASANO® Wound Cleansing Sponges Cavity & Interdigital

Where cleaning is difficult e.g. between toes, in wound pockets or in undermined wounds, the LIGASANO® wound cleansing sponges cavity & interdigital will help you! They have the same properties as our regular wound cleaning sponges and are only adapted in form for special applications.

LIGASANO® wound cleansing sponge intensive
Removes very persistent, viscous, firm and / or necrotic coatings, may absorb a lot of detritus.

LIGASANO® wound cleansing sponge medium
Removes viscous, firm and / or necrotic coatings, may absorb plenty of detritus.

LIGASANO® wound cleansing sponge soft
Removes soft coatings and biofilm.

wound cleansing sponge cavity & interdigital **intensive**

wound cleansing sponge cavity & interdigital **medium**

wound cleansing sponge cavity & interdigital **soft**

Please note: mechanical debridement **may cause** pain, even with the LIGASANO® wound cleansing sponge! Please pay attention to sufficient analgesia, if necessary. A moistening with wound irrigation solution can make sense. In the case of patients during a therapy with anticoagulants (e.g. Marcumar® or acetylsalicylic acid) an appropriate risk assessment has to be made. The wound treatment with LIGASANO® has to be made by physicians or medically trained personnel.

4.4.3 Effectivity of the Wound Cleansing Sponges

In a small multi-center observational study, that was conducted since February 2020, the effectiveness of a debridement with the LIGASANO® wound cleansing sponges was evaluated. The wounds were debrided with the sponges at least once a week by wiping or rotation technique. The scheduled observation period was eight weeks. Because there exists no measuring method for the amount of coatings, the measuring was done by subjective assessment of the wound experts. Additionally we enquired about what intensity of the wound cleaning pads and which wound dressing was used.
After debridment with the LIGASANO® wound cleansing sponges the wound was treated with a wound dressing at choice of the wound expert.
Up to now 18 study centers are included and 99 study packages have been handed out. The observational study has been completed for 37 patients.

The patients were between 40 and 93 years old, the average age was 73.1 years. The wound cleansing sponges were used in the study in 27 men and 8 women, the gender ratio is 3.4:1. Two patients did not specify their gender. The BMI of the participates is in average 28.5 kg/m² (17.9 to 39.0 kg/m²).
The following wounds were treated:
1 decubital ulcer
17 ulcera cruris
15 diabetic foot ulcerations
3 post-surgery wound (amputation wounds of diabetic feet)
1 decollement
The **wound coatings were reduced in the course of the treatment for 56.0%** (average).
The wound practitioners chose often the intensive LIGASANO® wound cleansing sponge, mostly in the size 5 x 5 x 2 cm, which was due to anatomy.

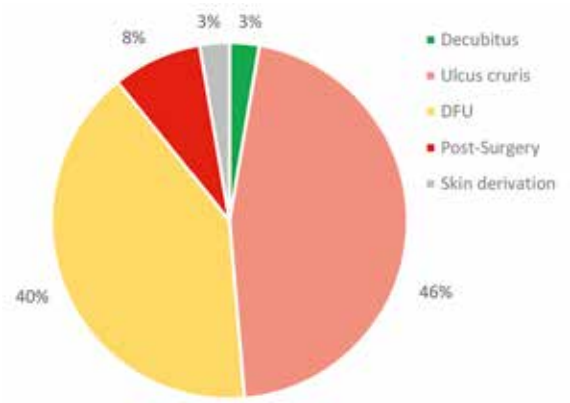


Fig. 4.4.3.1: Overview of the treated kind of wounds

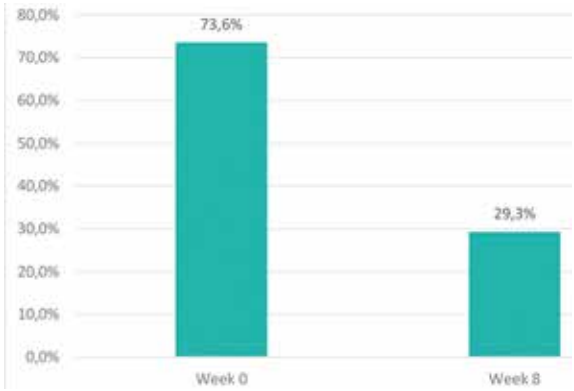


Fig. 4.4.3.2: Reduction of coatings during the treatment with LIGASANO® wound cleansing sponges

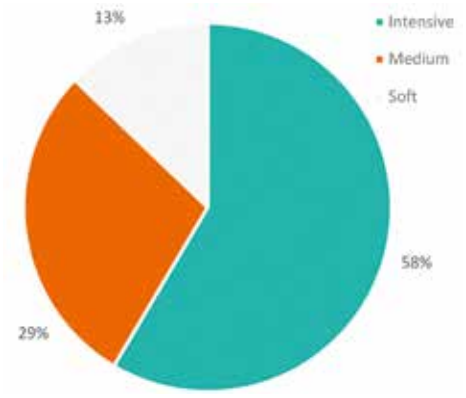


Fig. 4.4.3.3: Used intensity of LIGASANO® wound cleansing sponges

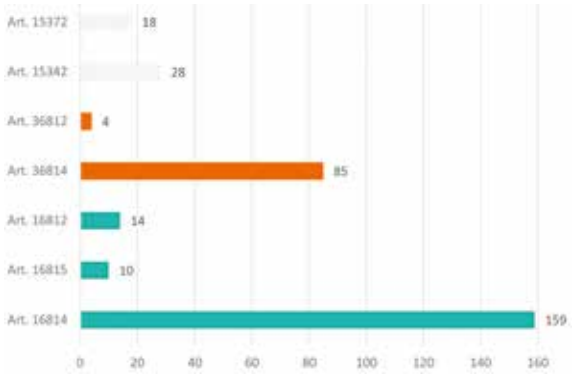


Fig. 4.4.3.4: Used articles of LIGASANO® wound cleansing sponges

The cleansing time decreased by 46.2% in the course of the eight-week treatment. From average 62.8 seconds to 33.8 seconds. Clensing time in week 1 was between 3 and 180 seconds, in week 8 between 2 and 120 seconds.

Fig. 4.4.3.5: Cleansing time in seconds during mechanical debridement with LIGASANO® wound cleansing sponges.

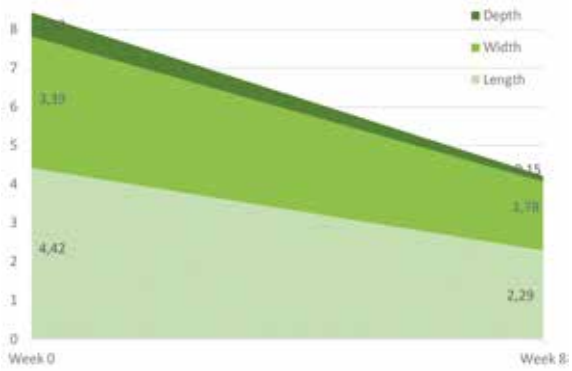


Fig. 4.4.3.6: Reduction of wound size during observation period, dimensions in cm

Pain intensity was reported by the patients on a pain scale from 1 (no pain) to 10 (greatest pain imaginable). **The pain sensation during the cleaning process was reduced from an average of 3.0 (slight pain) at the beginning of the treatment in week 1 to 1.7 (very slight pain) at the treatment in week 8**. This means a reduction of almost two thirds (65%), assuming that 1 means no pain, i.e. zero. It did not matter how long the cleaning process took. The type of wound or the underlying pre-existing disease was the decisive factor for the perception of pain.

All five treated patients who felt pain during treatment greater than 5 on the pain scale did not have neuropathy. Their wounds were decubital ulcers (1x) and leg ulcers (4x). Wound cleansing was carried out with the LIGASANO® wound cleansing sponge medium in three of the patients and with the LIGASANO® wound cleansing sponge intensive in two patients.

The **wound size decreased by 48.2% in length, 47.5% in width and 76.2% in depth** in the course of the eight weeks. In seven of the treated patients (i.e. in almost 27%) the wounds healed during the treatment period. In one patient, treatment had to be discontinued due to hospitalisation.

The wound healing phases shifted more and more towards epithelisation in the course of the eight weeks of treatment.

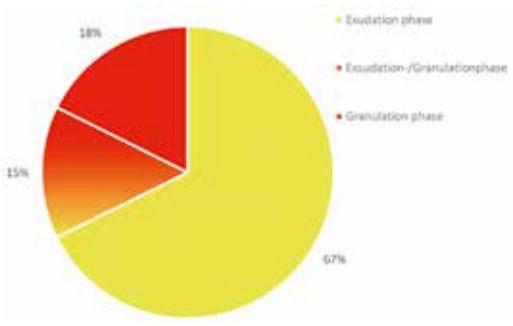


Fig. 4.4.3.7: Wound healing phases before treatment with LIGASANO® wound cleansing sponges.

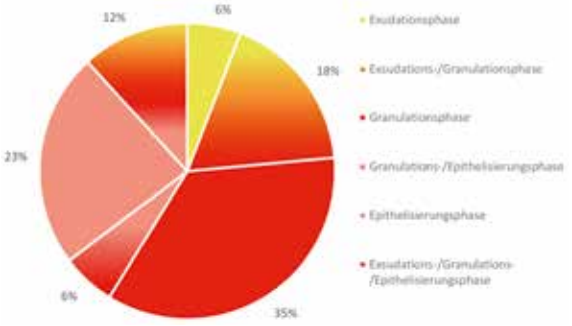


Fig. 4.4.3.8: Wound healing phases at the end of the observation period.

Apart from pain and discomfort during mechanical debridement, **no undesireable side effects** were observed.

The LIGASANO® wound cleansing sponges outclass the most debridement techniques in case of wet necroses, fibrin coatings and biofilm, but they are much less expensive than NPWT. If you pre-moisten dry necroses, the LIGASANO® wound cleansing sponges can act also in case of dry necroses with success.

Debridement method	Dry necrosis	Moist necrosis	Fibrin	Biofilm	Pain
Scalpel*	✓✓✓	✓✓✓	✓✓✓	✓✓	☹☹☹
Shaver*	✓✓✓	✓✓✓	✓✓✓	✓	☹☹☹
Curette**	✓	✓✓	✓✓✓	✓✓	☹☹☹
Wet-to-dry-dressings	✓	✓✓	✓✓	✓	☹☹☹
Wet-dry-phase	✓✓	✓✓	✓✓✓	✓✓	☹☹
Monofilament fibre pad	✓	✓	✓✓	✓✓✓	☹
Wound cleansing pad made of PU foam	✓	✓✓✓	✓✓✓	✓✓✓	☹
Jet-lavage**	✓✓✓	✓✓✓	✓✓✓	✓✓	☹☹
Ultrasound**	✓	✓✓	✓✓✓	✓✓✓	☹☹
NPWT	✓	✓✓✓	✓✓✓	✓✓✓	☹
Biosurgery (larvae)	✓✓	✓✓✓	✓✓✓	✓✓✓	☹☹
Enzymatic products	✓	✓✓	✓✓	✓	☹
Autolytic products	✓	✓	✓✓	✓	☹

Explanation of symbols in the overview of common debridement techniques

✓✓✓ = optimal
✓✓ = qualified
✓ = less or not qualified
* is performed with anaesthesia

☹ = little or no pain
☹☹ = bearable pain
☹☹☹ = severe pain
** is performed often with analgesia

If you split the table above according to the different coatings and subsequently assort according to effectivity and pain, you immediately recognise the potential of the LIGASANO® wound cleansing sponges.

Debridement method	Dry necrosis	Pain
Jet-lavage**	✓✓✓	☹☹
Scalpel*	✓✓✓	☹☹☹
Shaver*	✓✓✓	☹☹☹
Biosurgery (larvae)	✓✓	☹☹
Wet-dry-phase	✓✓	☹☹
Wound cleansing pad made of PU foam	✓	☹
Monofilament fibre pad	✓	☹
NPWT	✓	☹
Enzymatic products	✓	☹
Autolytic products	✓	☹
Ultrasound**	✓	☹☹
Curette**	✓	☹☹☹
Wet-to-dry-dressings	✓	☹☹☹

Debridement method	Moist necrosis	Pain
Wound cleansing pad made of PU foam	✓✓✓	☹
NPWT	✓✓✓	☹
Jet-Lavage**	✓✓✓	☹☹
Biosurgery (larvae)	✓✓✓	☹☹
Scalpel*	✓✓✓	☹☹☹
Shaver*	✓✓✓	☹☹☹
Enzymatic products	✓✓	☹
Wet-dry-phase	✓✓	☹☹
Ultrasound**	✓✓	☹☹
Curette**	✓✓	☹☹☹
Wet-to-dry-dressings	✓✓	☹☹☹
Monofilament fibre pad	✓	☹
Autolytic products	✓	☹

Debridement method	Fibrin	Pain
Wound cleansing pad made of PU foam	✓✓✓	☹
NPWT	✓✓✓	☹
Wet-dry-phase	✓✓✓	☹☹
Jet-Lavage**	✓✓✓	☹☹
Ultrasound**	✓✓✓	☹☹
Biosurgery (larvae)	✓✓✓	☹☹
Scalpel*	✓✓✓	☹☹☹
Shaver*	✓✓✓	☹☹☹
Curette**	✓✓✓	☹☹☹
Monofilament fibre pad	✓✓	☹
Enzymatic products	✓✓	☹
Autolytic products	✓✓	☹
Wet-to-dry-dressings	✓✓	☹☹☹

Debridement method	Biofilm	Pain
Wound cleansing pad made of PU foam	✓✓✓	☹
Monofilament fibre pad	✓✓✓	☹
NPWT	✓✓✓	☹
Ultrasound**	✓✓✓	☹☹
Biosurgery (larvae)	✓✓✓	☹☹
Wet-dry-phase	✓✓	☹☹
Jet-Lavage**	✓✓	☹☹
Scalpel*	✓✓	☹☹☹
Curette**	✓✓	☹☹☹
Shaver*	✓	☹☹☹
Wet-to-dry-dressings	✓	☹☹☹
Enzymatic products	✓	☹
Autolytic products	✓	☹

4.5 LIGASANO® white as Wound Dressing and Wound Filler (Tamponade)

You can use LIGASANO® white for all kinds and phases of wounds. In chapter 4.6 you will find many examples. Also the pre-surgical conditioning of wounds is a typical indication for LIGASANO® white. LIGASANO® white is available in sterile and non-sterile form. It must always be applied by a physician or medically trained personnel.

4.5.1 General Information for Application

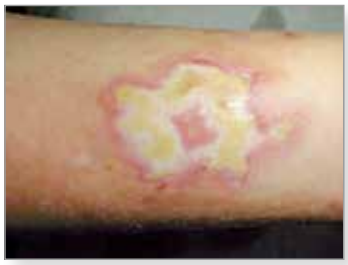
In so far as the wound allows the outflow of secretion, you can treat it directly with LIGASANO® white without any pre-treatment. Fill the wound completely out with LIGASANO® white. Observe that complete contact with the wound is insured, also at the wound edges. You have to fill out existing pockets, too.

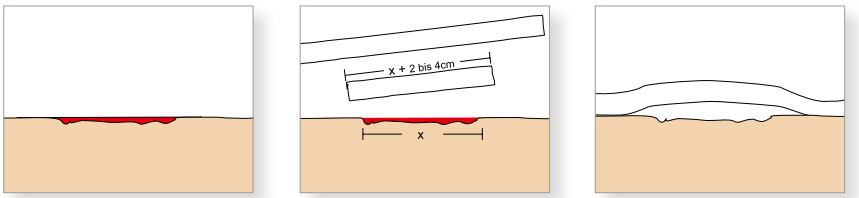
Therefore cut LIGASANO® white to somewhat larger than the wound diameter. Insert it into the wound with slight compression, to make reliable contact everywhere. Only where LIGASANO® white has contact, it does works.

Then the wound is covered with another layer of LIGASANO® white, overlapping the wound edges by at least 1-2 cm. Above it put a great sheet LIGASANO® white for the treatment of wound environment.
Dressing thickness: Also in case of skin-deep wound the tickness of LIGASANO has to be at least 2 cm, measured from the wound ground. For all other wounds the dressing thickness has to be accordingly thicker. Rule of thumb: the greater the area of the treated wound environment, the better the effect.
Fixation must always be permeable to air. Good qualified for this are fixation pants, tubular bandages or at the best LIGAMED® *fix*.
Dressing change frequency: 1x daily to 1x every 3 days, but in any case as soon as the first sign of secretion becomes visible on the outside of LIGASANO® white. Wounds which heavily suppurate during the cleaning phase should therefore also be changed several times daily.

4.5.2 Application on Different Kinds of Wounds

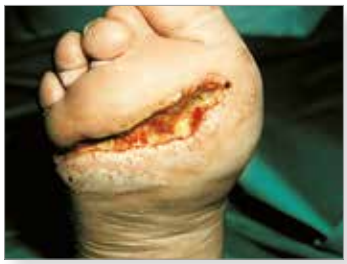
Skin-deep wound (up to a depth of 0.5 cm)

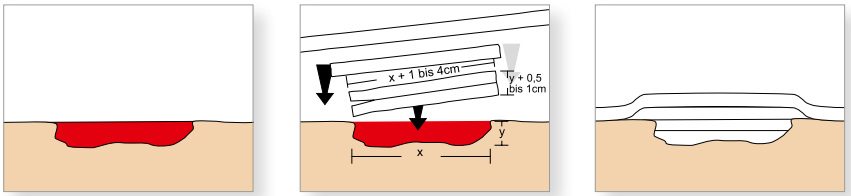




- Complete covering of the wound with LIGASANO® white, from skin level at least 2 cm thick
- Wound edges at least 2 cm overlapping
- Observe that complete contact with the wound is also insured on deeper locations of the wound
- Generously cover the wound environment with LIGASANO® white for local promotion of blood flow
- Air-permeable fixation

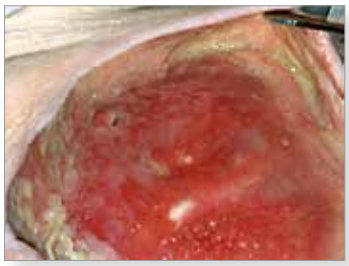
Deep wound

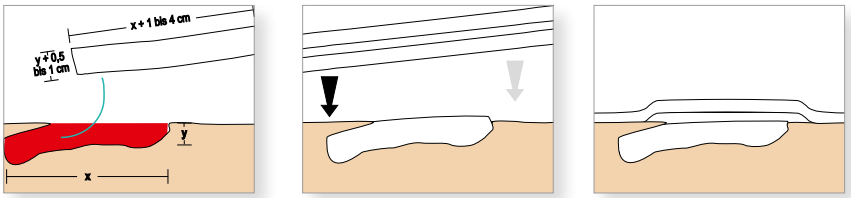




- Completely fil the wound with LIGASANO® white. Therefore cut LIGASANO® white to somewhat larger than the wound diameter and to somewhat thicker than the wound depth
- Insert LIGASANO® white into the wound with slight compression, there must be complete contact to the wound everywhere, also at the wound edges
- Generously cover the wound and the wound environment with LIGASANO® white
- Air-permeable fixation

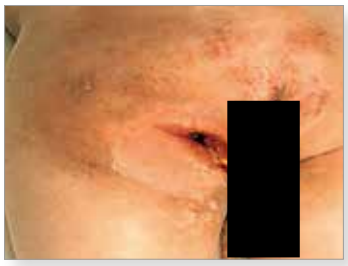
Deep wounds with undermining





- First, completely fill out the undermining or pocket (wound filler, tamponade) and then the wound with LIGASANO® white. Therefore cut LIGASANO® white to somewhat larger than the wound diameter and to somewhat thicker than the wound depth
- Insert LIGASANO® white into the wound with slight compression, there must be complete contact to the wound everywhere, also at the wound edges and underminings
- Generously cover the wound and the wound environment with LIGASANO® white
- Air-permeable fixation

Wounds with narrow opening / fistulae



- Fill the wound completely with the cavity dressings LIGASANO® white wound strip, mini wound strip, micro wound strip or sticks (depending on the volume of the wound). Firstly explore direction and depth of the wound, so that you can reliable reach the bottom of the wound.
- Generously cover the wound and the wound environment with LIGASANO® white
- The wound strip should assume a zigzag pattern in the wound. Almost no friction is generated when extracting the strip from the wound. Dressing change is quick, easy and with relatively little pain. A premature, superficial closure of the wound will prevented.
- Air-permeable fixation

4.5.3 Possible Combinations with Other Products

LIGASANO® white with polyhexanide gel and superabsorbent dressings

At the center for vascular medicine and wound treatment of the Stiftungsklinikum Mittelrhein, Germany, Dr. med. Gunnar Riepe and his colleagues developed the "Boppard LaLiSo concept for heavy exudating ulcus cruris venosum". Even though this wound treating conception was developed for the stationary area, but has now high acceptance in ambulatory nursing service.
The authors had looked for a wound dressing, that is macropored enough, to absorb also thicker exudate fractions as well as it is combinable to a superabsorber. The first and only solution they have found in a combination of Lavasept® Gel with the macro-pored PU foam LIGASANO® and the hyperabsorber Sorbion® Sachet®. From the initial syllables of the names Lavasept®, LIGASANO® und Sorbion® the internal abbrevation LaLiSo has developed.

Fig. 4.5.3.1: Lavasept® Gel and LIGASANO® white in small cubes.

Fig. 4.5.3.2: Sorbion® Sachet® Superabsorber over the foam.

Fig. 4.5.3.3: Removed foam cubes with the solid parts of the wound exudate.

LIGASANO® white with polyhexanide gel

The clinic for paediatrics at the St. Josef Hospital in Bochum/Germany uses a combination of LIGASANO® white, LIGASANO® green and Lavasept® (polyhexanide) gel for the open wound treatment of burns. For this wound treatment we place LIGASANO® green on the bed, which is provided with sterile bedclothes and put thereon one sheet of LIGASANO® white. Before we lie down the little patients we cream them with Lavasept® gel.
The open wound treatment is still made only rarely, because the severe burned children would lie in their room alone for 24 hours, wouldn´t be mobile and would have an enormous psychological stress.

Fig. 4.5.3.4

Fig. 4.5.3.5

Fig. 4.5.3.6

LIGASANO® white with absorbent dressing

Fig. 4.5.3.7

Fig. 4.5.3.8

Fig. 4.5.3.9

LIGASANO® white with breathable adhesive non-woven fixation

Fig. 4.5.3.10

Fig. 4.5.3.11

Fig. 4.5.3.12

4.5.4 Risks and Side Effects, Contraindications

Wound cleaning: mechanical debridement may cause pain, even with LIGASANO® white sterile.
Wound treatment: because of its cell structure a vascularisation (e.g. of granulation tissue) into the material is possible. You can prevent this with a timely dressing change, after 1-3 days using LIGASANO® white sterile. On passive wounds or parts of the body that receive poor blood supply, pain may occur after application. This occurs when the blood circulation is stimulated by the mechanical stimulus of the material to such an extent, that previously diminished or reduced pain returns. Initially the pain can be intense, however it is usually regulated after a few hours to days. If this effect is not desired, you should forgo its application. Too much pressure due to the material's prior tension, external influence, or suction may lead to compression of vessels and therefore to pressure ulcers.
It may occur that LIGASANO® white sterile sticks to the wound, mostly due to too much air reaching the wound. This means that the LIGASANO® white sterile dressing is not thick enough (it should be 2 cm from skin level). LIGASANO® white can be moistened on the side facing the wound (e.g. with Ringer´s solution or wound irrigation solution) to prevent it from sticking.
If hypergranulation occurs, please treat it appropriately and switch to other dressing material groups, if necessary.
LIGASANO® white is a very simple product and its effects are due to its structure. It does not contain nor emit any active compounds. With the correct application of LIGASANO® white there are no known negative side effects, nor incompatibility or interactions with medicine. Typical side effects may include reddening of the skin upon contact and initial "itching". More intense side effects may include return of sensitivity due to stimulation of local blood circulation. Its effects are only physical and end almost immediately after discontinuation of application. As with all wound dressings, minor skin reactions such as maceration, erythema, secondary infected dermatitis, erysipelas as well as hypersensitivity reactions and pain at dressing change may occur.
Please report any incidents that have occurred in connection with our dressing material LIGASANO® white sterile to us or to the competent authority of the member state in which the incident occurred.
Contraindications: Tumour wounds and untreated osteomyelitis. Not suitable for contact with organs, contact to exposed blood vessels with the danger of damage, or contact with nerves.

4.5.5 Dressing change frequency:

LIGASANO® white sterile is suitable for single use only. Sterility is ensured only by intact packaging. The product must not be used after the expiration date and is not suitable for reconditioning or re-sterilisation due to its potential for contamination.
LIGASANO® white sterile must not continuously remain in the wound or on the body. The application may be repeated over a period up to 12 months, always with a new dressing. Dressing change after 1-3 days, depending upon the indication. Please consider that LIGASANO® white sterile must not have direct contact to organs. It may have direct contact to mucosa.

4.6 Examples for the Treatment of Wounds of Different Aetiology

LIGASANO® white is applicable for all kind of wounds and every wound phase. A pre-surgical wound conditioning is also a typical indication for LIGASANO® white.

4.6.1 Pressure Ulcer

The area of local damage of the skin and the subjacent tissue, caused significantly by too high and/or too long pressure or shearing forces on skin and tissue, is termed decubitus ulcer (pressure ulcer). If the extrinsic pressure, which impacts on the vessels, exceeds the capillary pressure of the vessels, it comes to trophic (concerning the nutrition of the tissue) impairments. Mostly the own weight of the particular unmoved body part suffices. Different studies for the determination of the capillary pressure show pressure values between 32 and 70 mmHg, that lead to an interruption of the blood supply. If this pressure load persists for a longer time, it comes - as a result of an undersupply of the cells with oxygene and nutrients - to a decrease of the partial oxygene pressure to 0 mmHG (ischaemia) as well as an accumulation of toxic metabolites and consequential to formation of tissue necrosis and irreversible damage of nerve cells. At elder and sick persons this reflexes are often only limited or lacking and thus the neccessary pressure relief of the tissue does not happen. To this hyperacidity of the tissue the body reacts with vascular dilatation, so that this areas are better supplied with blood. The implication is a non blanchable redness, that does not subside after the pressure is relieved, a decubitus stage I. Especially at risk are areas with little soft tissue covering and outward curved abutements, as sacrum region, heels, femoral trochanter and ankles.
"Because of the essential importance of pressure and shearing forces at the development of pressure sores, you have to consider factors, which cause a prolonged and/or higher exposure of pressure and shearing forces, both at the initial examination for risk elimination as well as at the differentiated risk evaluation. To this especially limitations in activity and mobility as well as exterior and medical-custodial caused influences belong."(Expertenstandard Dekubitusprophylaxe in der Pflege, 2. actualisation, page 23). The following table shows an overview.

Reasons for increased and/or prolonged effect of pressure and/or shearing forces
Reduction of mobility **Definition:** Mobility refers to one's own movements with the aim of moving or altering the body, and includes the ability to control one´s body position. Limitations (selection): • Impaired ability to make small changes in position independently while lying or sitting • Little or no control over (pressure-relieving) body positions in lying or seating position • Impaired ability for independent transfer, e.g. from bed to chair (or reverse) or from a sitting in a standing position (or reverse) The **assessment** of existing limitations of mobility should consider the following conditioning and influencing factors for a differenciated assesment for decubitus risk and the deduction of individual required preventive measures: • Status of mobility before starting the actual nursing process • Individual physical, cognitive and psychical impairments and ressources • Parameters of the social and material environment (e.g. relatives, aids, spatial barriers) • Therapeutic influence factors (e.g. mobility impairing medication)
Extrinsic resp. iatrogen caused influence factors (selection): • Catheters and tubes, which impress on the body´s surface; or objects, which lie in bed or on the chair (e.g. remote control) and devices respectively (e.g. hearing aid) • Nasal and endotracheal tubes • Too tight or poor fitting splints, dressings, protheses for leg or arm • Insufficient pressure distributing devices for positioning • Surgeries with longer duration

Table adapted from: Deutsches Netzwerk für Qualitätsentwicklung in der Pflege (Hrsg.), Expertenstandard Dekubitusprophylaxe in der Pflege, page 24; 2. actualisation 2017, ISBN 978-3-00-009033-2

Risk factors for the development of a pressure ulcer lie in some extend with the patients theirselves (intrinsic factors), as for example reduced mobility, old age, malnutrition, dehydration, weight, additional diseases, infections, urinary and/or anal incontinence, disturbed sensibility, etc.; and on the other hand the risk factors lie in the patients´ environment (extrinsic factors), as for instance mobilisation, time intervals of bedding, skin care. Further extrinsic factors, which may cause a pressure sore, are shearing forces, friction, too high temperatures and heavy moisture (maceration of the skin). Open decubital ulcers can be a portal of entry for germs, which are able to cause not only a local but a generalised infection. The best therapy of a pressure ulcer is still its prevention! Don´t let it come to this. Examples for pressure relief please find in chapter 5.4 (page 78 - 88).

Classification of Pressure Ulcers in the International Guideline of NPUAP, EPUAP and PPPIA:

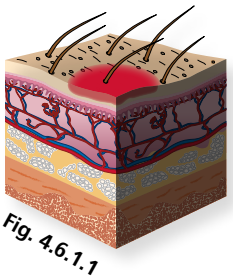


Fig. 4.6.1.1

Category/Stage I: Nonblanchable Erythema

Intact skin with non-blanchable redness of a localized area usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area.
The area may be painful, firm, soft, warmer or cooler as compared to adjacent tissue. Category/Stage I may be difficult to detect in individuals with dark skin tones. May indicate "at risk" individuals (a heralding sign of risk).

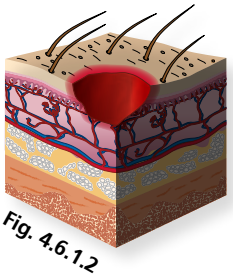


Fig. 4.6.1.2

Category/Stage II: Partial Thickness Skin Loss

Partial thickness loss of dermis presenting as a shallow open ulcer with a red pink wound bed, without slough. May also present as an intact or open/ruptured serum-filled blister.
Presents as a shiny or dry shallow ulcer without slough or bruising.* This category/stage should not be used to describe skin tears, tape burns, perineal dermatitis, maceration or excoriation.
*Bruising indicates suspected deep tissue injury.

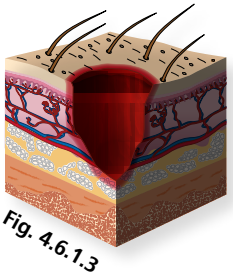


Fig. 4.6.1.3

Category/Stage III: Full Thickness Skin Loss

Full thickness tissue loss. Subcutaneous fat may be visible but bone, tendon or muscle are not exposed. Slough may be present but does not obscure the depth of tissue loss. May include undermining and tunneling.
The depth of a Category/Stage III pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and Category/Stage III ulcers can be shallow. In contrast, areas of significant adiposity can develop extremely deep Category/Stage III pressure ulcers. Bone/tendon is not visible or directly palpable.

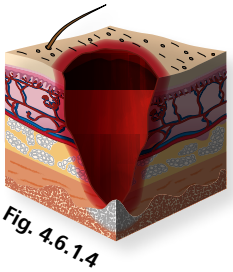


Fig. 4.6.1.4

Category/Stage IV: Full Thickness Tissue Loss

Full thickness tissue loss with exposed bone, tendon or muscle. Slough or eschar may be present on some parts of the wound bed. Often include undermining and tunneling.
The depth of a Category/Stage IV pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and these ulcers can be shallow. Category/Stage IV ulcers can extend into muscle and/or supporting structures (e.g., fascia, tendon or joint capsule) making osteomyelitis possible. Exposed bone/tendon is visible or directly palpable.

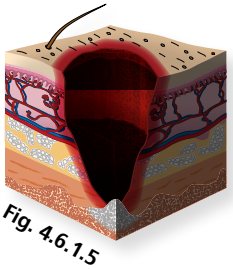


Fig. 4.6.1.5

Unstageable: Depth Unknown

Full thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green or brown) and/or eschar (tan, brown or black) in the wound bed.
Until enough slough and/or eschar is removed to expose the base of the wound, the true depth, and therefore Category/Stage, cannot be determined. Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels serves as 'the body's natural (biological) cover' and should not be removed.

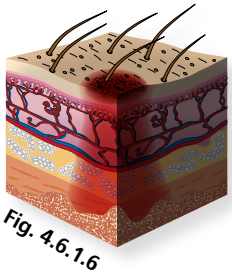


Fig. 4.6.1.6

Suspected Deep Tissue Injury: Depth Unknown

Purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue.
Deep tissue injury may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark wound bed. The wound may further evolve and become covered by thin eschar. Evolution may be rapid exposing additional layers of tissue even with optimal treatment.

Text from: National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Western Australia; 2014 Illustrations: © LIGAMED® medical Produkte GmbH

Note: Macerations of the skin are often mistaken for pressure sores. But this both are different diseases with completely different causes and according to this they need different treatment.

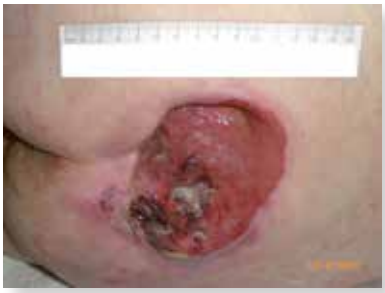


Fig. 4.6.1.7

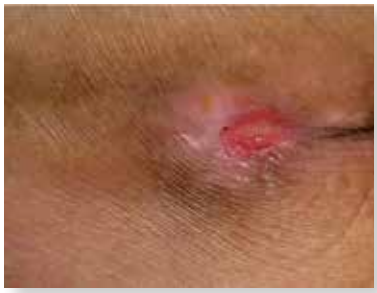


Fig. 4.6.1.8

	Pressure ulcer	Maceration caused lesion
Localisation	developes over bones (e.g. sacral bone)	develops in a skin fold (e.g. on the tail bone)
Wound environment	clearly demarcated	diffuse extend
Wound base	poor blood supply, possibly with necrosis	good blood supply, wound is not deeper than dermis

Tab. 4.6.1.9

Finger test by Phillips:
By this test you can distinguish a decubital ulcer category 1 from an erythema of different aetiology. The test was described in 1997 by Jenny Phillips:

Press a finger on the erythema:
If a white outline occurs and the fingerprint looks **white for a short moment** after release, is it a reddenish, which you can push away. Thus the finger test is negative. This is **no decubital ulcer**, but an allergy or inflammation caused erythema.

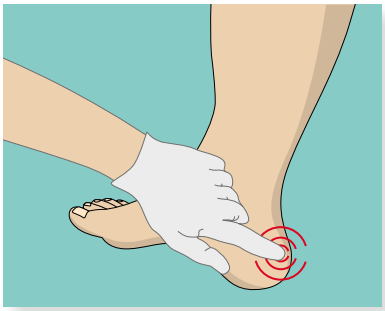


Fig. 4.6.1.10

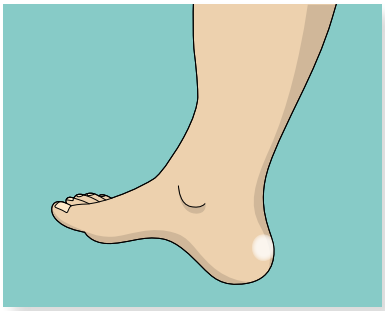


Fig. 4.6.1.11

If the **reddenish cannot pushed away** and persists after release, the fingertest is positive: this is a **pressure-induced skin damage**.

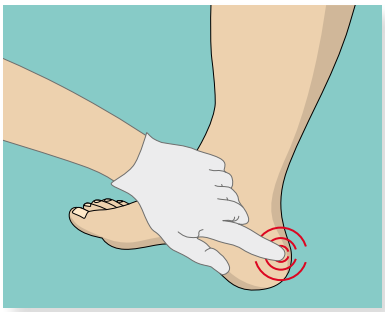


Fig. 4.6.1.12

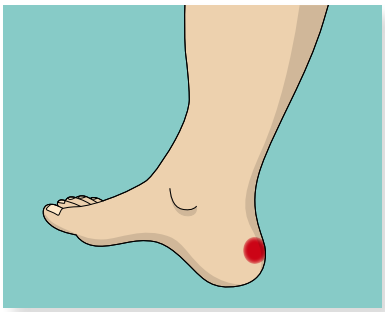


Fig. 4.6.1.13

Treatment example:

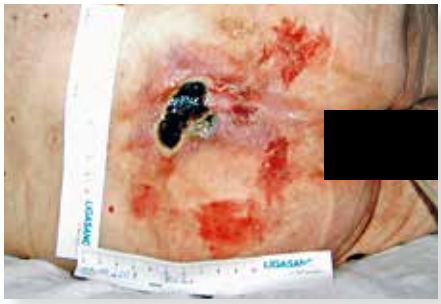


Fig. 4.6.1.14

93 years old, female, completely immobile, incontinent, in bad general condition and nutrition status too, was found at home bedraggled. Hitherto her sons attended to her, but now she is accommodated in a nursing home, for the present short-time care. Multiple pressure sores at the heels and both trochanters.
Pre-existing diseases: hemiparesis at the right side due to apoplexy two years ago, no diabetes mellitus.
Medication: until her accommodation none, now for the treatment of an urinary infection a therapy with antibiotics.
Findings on admission on 11/10/2007: after removal of the hitherto used hydrocolloid dressing and systematic cleaning of the wound with saline solution (0.9%), appears a great and moist necrosis with a dimension of 6.0 x 4.0 cm over the sacrum. The surrounding wound area was reddened, up to 15 cm around the wound, over-heated and macerated, partly ablation of the epidermis. Multiple smaller pressure ulcers due to the wrinkled hydrocolloid dressing (fig. 4.6.1.14)
The dressing with LIGASANO® white was arranged in layers: one sterile compress of LIGASANO® white with a thickness of 1 cm, moistened with Octenisept® and applied to the wound. The covering is made with another sterile compress with the size 24 x 16 cm and on it one piece of unsterile LIGASANO® white, cut to a size of ca. 25 x 25 cm. Fixation around with strips of dressing film, because the patient has shown a cutaneous reaction to conventional plaster.
It is good to see the property of the vertical absorption of exudate of LIGASANO® white (fig. 4.6.1.15). The exudate is steadily drained off outwards. Already 24 hours later we could open the necrosis. It has shown a pocket that goes up to 3.0 cm to cranial. This wound pocket and the undermined wound edges, which developed during the proceeding wound cleaning, were packed with stripes of LIGASANO® white. The large-area use of LIGASANO® white has proved very favourably, especially for the use at pressure ulcers. By this the effect that is favouring the blood flow and the property of pressure relief is used on the greatest possible area.The patient was badly approachable, but this has been improved during her stay considerably. Already two weeks later she was partly mobilised. A communication was possible, but hindered because of her extreme hearing impairment.

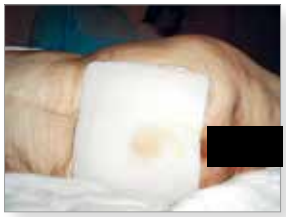


Fig. 4.6.1.15

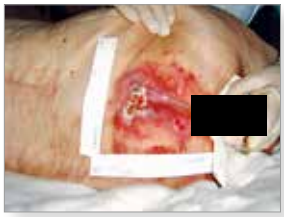


Fig. 4.6.1.16

Fig. 4.6.1.17

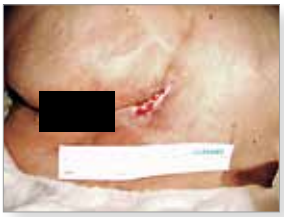


Fig. 4.6.1.18

Findings on 19/10/2007: the lesions of the surrounding skin areas are healed to a large extend. The reddening results of a meantime occurred intestinal infection with watery diarrhoea. This healed within three days, while we changed the dressing more often. Dressing change up to now once daily. Apart from remaining small fibrinous coatings in the pocket, the wound is well supplied with blood, clean and granulating (fig. 4.6.1.16).
Findings on 14/11/2007: granulating wound, epithelisation from the wound edges. The surrounding wound area is intact and stable. Dressing change is now every 2-3 days, depending on her defaecation frequency. We retained the size of the outer dressing to maintain the pressure relief furthermore (fig. 4.6.1.17).
Findings on 20/12/2007: the wound is clean, the surrounding area is intact and not irritated (fig. 4.6.1.18).
Findings on 11/01/2008: the epithelisation is nearly completed. The patient is mobilised and increasingly participates in the daily routine of the nursing home (fig. 4.6.1.19).

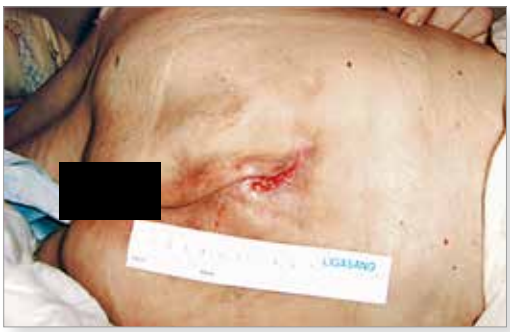


Fig. 4.6.1.19

Summary:
Due to the easy application of LIGASANO® white (only one product for wound healing, dressing change is quick and easy), its effect of favouring the blood flow and its property of pressure relief you can realise satisfying results even in the case of complicated initial situations.

4.6.2 Ulcus Cruris

The ulcus cruris, an ulcer of the lower leg, is an open, mostly weeping sore ("ulcerated leg"), which does not heal during a long time. This type of ulcer is known since time immemorial. In the majority of cases elder people with different underlying diseases are struck, women more often than men. According to information of the AOK (the biggest German health insurance), in Germany more than one million people suffer from this so-called ulcerated legs. About 80-85% are of venous origin, approximately 10% are of arterial origin and the rest are arterial-venous mixed ulcerations or ulcerations of other genesis. The fundamental reason of all types of leg ulcers is the lacking perfusion of the tissue. This lacking perfusion is responsible both for the development of the ulcus cruris and for its bad healing. In all patients with leg ulcer, an ankle-brachial-index measurement (= ABI) should be made to exclude or determine the severity of the PAOD. The ankle-brachial pressure index is the quotient of the systolic blood pressures measured on the lower leg and the upper arm. A quotient from 0.9 to 1.2 is normal. The smaller the quotient, the more severe is the circulatory disorder. A value under 0.5 implicates mostly a clinical ischaemia with a high risk of necrosis and ulceration. Values, which are clear over 1.3 suggest a medial arteriosclerosis.
Example: Measurement at the upper arm 100 mmHg, measurement at the lower leg 50 resp. 60 mmHg. The ABI is 0.6, that correlates to a peripheral arterial obstructive disease state III-IV.

a) **Ulcus cruris venosum**
The venous ulcus cruris is caused by a chronic phlebasthenia (chronic venous insufficiency, CVI) and appears in most cases interior of the lower leg, little above the ankle. Inspection and measuring of the ulcer, preferably with photographic documentation, facilitate the subsequent evaluation of the therapeutic method and the patient´s compliance, too. As a diagnostic method for the genesis of the disease the duplex sonography of the veins is used. At venous insufficiency the physician has to examine if a surgical intervention may bring improvement and thus a quicker healing of the ulcer.

Practical tip: venous ulcus cruris

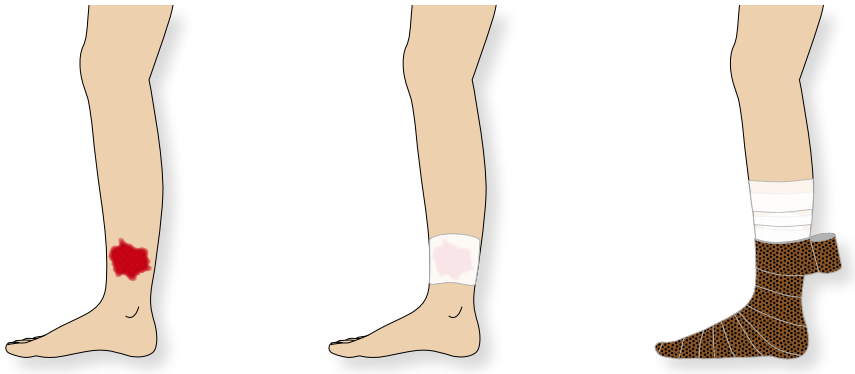


Fig. 4.6.2.1

Typically the venous ulcus cruris is a very heavily exudating wound. The main problem is, to absorb great amounts of exudate and to canalise in the way that it does not overflow to the wound edges.
Fill the heavily exudating wound with LIGASANO® white and cover the wound edges, overlapping at least 2 cm, also with LIGASANO® white. The overflow of the wound edges is prevented, if you change the dressing in time. Surplus of exudate is absorbed. Sometimes it makes sense to use a superabsorbent polymer additionally. The concomitant therapy (compression bandage, compression stocking) can be carried out as usual.

Grading CVI / Classifikation according to Widmer (modified after Marshall)

	Widmer	Widmer-Marshall
CVI I° grade	Corona phlebatica paraplantaris	a) Corona phlebatica paraplantaris, stasis dermatitis b) like a) with clinical detectable oedema
CVI II° grade	Pigment shifting (dermite ocre), eczema („stasis dermatitis")	Dermatoliposclerosis with or without atrophy blanche + oedema (of different shape)
CVI III° grade	Leg ulcer or ulcer scar	a) Healed leg ulcer b) Florid leg ulcer alternatively: CVI III° Healed leg ulcer (ulcer scar) CVI IV° Florid leg ulcer

Table 4.6.2.2: (translated) from:
S3-Leitlinie 091-001 „Lokaltherapie chronischer Wunden bei den Risiken CVI, PAVK und Diabetes mellitus.

b) **Ulcus cruris arteriosum**

The arterial ulcus cruris is caused by arterial insufficiency and appears in most cases at the exterior of the lower leg. Inspection and measuring of the ulcer, preferably with photographic documentation, facilitate the subsequent evaluation of the therapeutic method and the patient´s compliance, too. As diagnostic methods for the genesis of the disease, duplex sonography and angiography is used. At arterial insufficiency the physician has to examine if a surgical intervention may bring improvement and thus a quicker healing of the ulcer.

Practical tip: arterial ulcus cruris

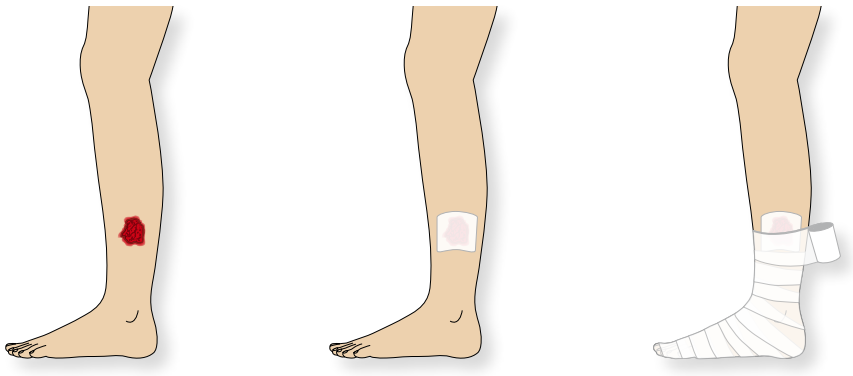


Fig. 4.6.2.3

Arterial perfusion disorders usually start below the knee. If there is no arterial occlusion, the LIGASANO® white bandage can serve your patient very well.
Locally treat the leg or foot lesion with LIGASANO® white. The LIGASANO® white bandage generates the blood flow promotion effect. The LIGASANO® bandage with a width of 5 or 10 cm is applied like a normal padding bandage. Thus you achieve padding and promotion of blood flow at the same time.
The LIGASANO® white bandage mostly does not get out of place. Additionally it can be fixed with a tubular net bandage or LIGAMED® *fix*.

Classification of PAOD according to Fontaine and Rutherford

Fontaine stadiums				Rutherford categories
Stadium	**Clinical picture**	**Grade**	**Category**	**Clinical picture**
I	Asymptomatic	**0**	**0**	Asymptomatic
IIa	Walking range > 200 m	**I**	**1**	Mild intermittent claudication
IIb	Walking range < 200 m	**I**	**2**	Moderate intermittent claudication
III	Ischaemic pain at rest	**I**	**3**	Severe intermittent claudication
IV	Ulcer gangrene	**II**	**4**	Ischaemic pain at rest
		III	**5**	Small-area necrosis
		III	**6**	Large-area necrosis

Table 4.6.2.4: (translated) from S3-Leitlinie 091-001 „Lokaltherapie chronischer Wunden bei den Risiken CVI, PAVK und Diabetes mellitus.

c) **Ulcus cruris mixtum**

This mixed leg ulcer is especially difficult to treat, because actually reasonable therapies are contradictory. To stimulate the venous return, a compression therapy is indicated; but this constricts the arterial influx, which is already too low, even more.

Practical tip: arterial-venous ulcus cruris

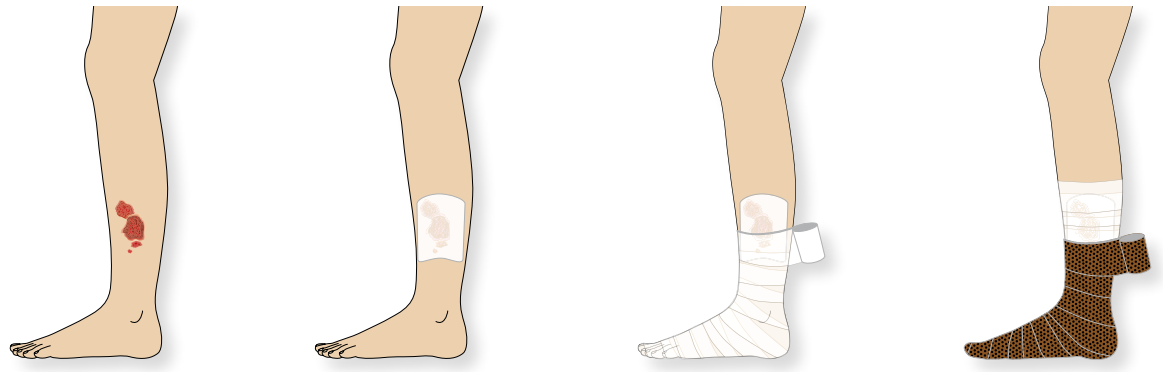


Fig. 4.6.2.5

The arterial-venous leg ulcer is particularly difficult to treat, because on the one hand the required blood flow is missing and it is additionally hindered by compression measures due to the insufficient drainage. Fill the usually exudating wound with LIGASANO® white and cover the wound edges, overlapping at least 2 cm, also with LIGASANO® white. The overflow of the wound edges is impossible, if you change the dressing in time.
Apply the LIGASANO® white bandage, 5 or 10 cm wide, just like a normal padding bandage under the compression dressing or the compression stocking. You achieve padding and promotion of blood flow at the same time. The wrapping of the compression bandage depends on the vascular status.

Treatment example 1:

88 years old, female, partly mobile, moves with assistance up to 20 steps with the walking frame, otherwise in the wheel chair, moves hardly independently. Very fearful, walks insecure, intellectual agile, little hearing impaired. Lives with her children and grandchildren at home. She is supported in the basic care by them and a nursing service. Arterial-venous mixed ulcer, skin and lower leg very dry and scaly. According to information of her family members, she suffers from dry skin and pruritus and reacts sensible to body care products and plaster.
Pre-existing diseases: cardiac insufficiency, arthrosis of the hips, recurrent water retentions in the lung and both lower legs, no diabetes mellitus.
Medication: beta blocker, diuretic agents if required, medication for decholesterolisation.
Diagnostic findings of the ulcerations on 12/10/2007: very painful wounds, a lot of fibrinous coatings and in places dry necrosis. Oedema at both lower legs; the skin is dry, stretched and shiny. After consulting the family doctor we have begun the treatment with sterile LIGASANO® white, all in all with a thickness of 2 cm, overlapping the wounds generously. Daily dressing change.
Findings on 05/11/2007: the ulcerations show defined wound edges. In all three wounds are very tight fibrinous coatings, in the upper ulcer precipitate spalls of chalk, which we can remove only badly and painfully for the patient (fig. 4.6.2.6).
Findings on 04/12/2007: considerable reduction of the lower ulcus. The middle ulcus is granulated except for slack fibrinous coatings, which we can remove mechanically. The upper ulcus is granulated to the niveau of the skin and is now in the phase of epithelisation (fig. 4.6.2.7).

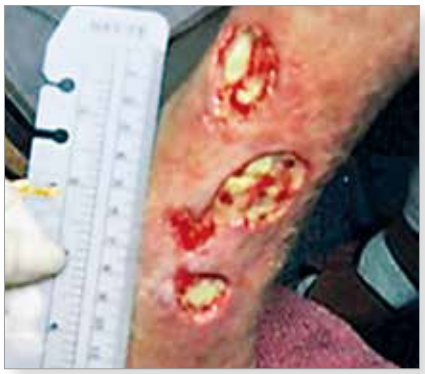


Fig. 4.6.2.6

Because of an allergic reaction to a skin care product, a new ulcer at the left inner ankle developed. Here we use the same dressing system with LIGASANO® white, covering the complete ankle (fig. 4.6.2.8).
Findings on 19/03/2008: state of the ulcer of the left lower leg, inner ankle: with the extensive use of LIGASANO® white the bland plaques have loosened in the wound environment of the inner ankle and have begun to weep

heavily. The primary ulcer granulated well and begins to minimise. Dressing change every 2-3 days, depending on the quantity of exudate (fig. 4.6.2.9).
State of the ulcer of the left lower leg, tibia and lateral ankle: the lower ulcer is granulated almost up to skin level, with beginning epithelisation. The middle ulcer is already significantly smaller and the upper ulcus is nearly closed (fig. 4.6.2.10).
Findings on 24/04/2008: state of the ulcer of the left lower leg, inner ankle: complete epithelisation at the inner ankle, only skin care, yet (fig. 4.6.2.11).
State of the ulcer of the left lower leg, tibia and lateral ankle: the lower ulcer is granulated up to skin niveau, the epithelisation proceeds. The middle ulcer is epithelisated, the wound environment is intact (fig. 4.6.2.12).

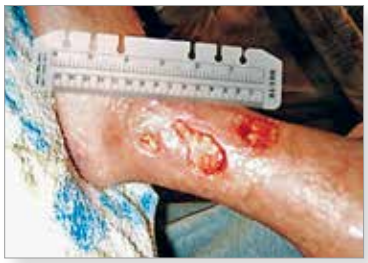


Fig. 4.6.2.7

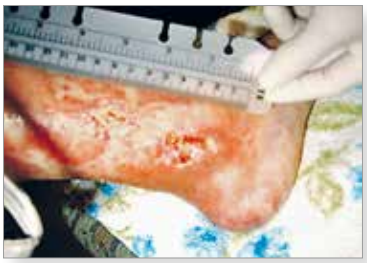


Fig. 4.6.2.8

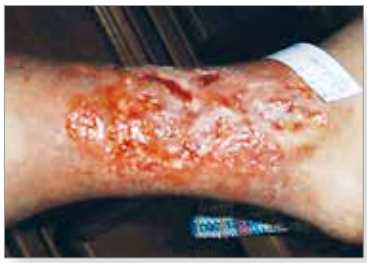


Fig. 4.6.2.9

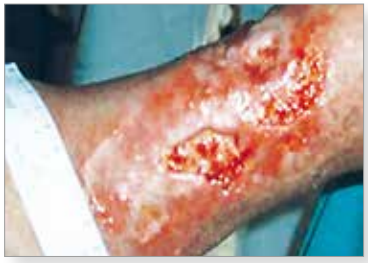


Fig. 4.6.2.10

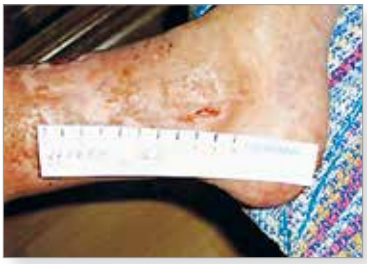


Fig. 4.6.2.11

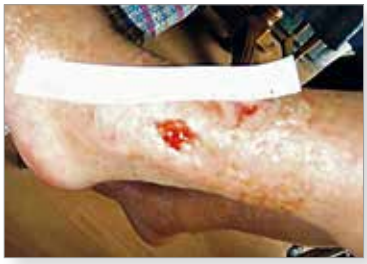


Fig. 4.6.2.12

Summary:
In this case the easy application of LIGASANO® white and its reliable effect of favouring the blood flow has shown, that it is possible to heal an arterial-venous mixed ulcer only with one product.

Treatment example 2:

Leg ulcer treatment by tangential excision and skin grafting (SCHMELLER´S METHOD), by Adrian Botan MD, senior consultant plastic surgeon, chief of the burn centre & plastic surgery department, county emergency hospital of Targu-Mureş/Romania.
Leg ulcers are over 50% of all chronic wounds operated in this department, and for this reason, in the last 6-7 years, they have imagined a "treatment protocol" for large lesions (over 8-10 cm diameter) especially. The most part of these ulcers are first cared in the office for about 6-8 weeks, with the polyurethane foam dressings LIGASANO® which are changed at three, five or even seven days, depending on the exudate quantity of every wound. (**Annotation of LIGAMED®: according to our instructions for use, the LIGASANO® dressing has to be changed at the latest after three days.**) The LIGASANO® foam is always combined with compression therapy by elastic bandages. After the complete "passive debridement" by this method (which they call "synthetic maggot therapy"), all patients with large ulcers are admitted for surgery in the hospital.
All wounds are clean, granulating and have a small quantity of exudate; beside this, the bacterial population decrease and change into a less aggressive one, as well as the area of lipodermatosclerosis decrease in size and the wound edges soften. LIGASANO® dressings are also used during the first 10-14 days in the hospital, before surgery, after that the ulcers are debrided by tangential excision (SCHMELLER'S METHOD); the final result of this "shaving" is a supple, well bleeding, pre-fascial surface. The hard, infiltrated edges of the ulcers are also excised, that is why the remaining wound is always larger than the initial one. Dr. Botan has noticed that in the rare cases when he did not use (for different reasons) the LIGASANO® foam dressing before surgery, he could not obtain the same well vascularised wound bed and beside this, the area of lipodermatosclerosis did not decrease in size and wound edges did not soften. After this tangential excision, the remaining bleeding surface was covered immediately by meshed split skin grafts (when brisk bleeding occurres, skin grafting can be delayed for 24-48 hours); 10-14 days after full take of the grafts, the LIGASANO® dressing and compression therapy are resumed (but the dressings

are now changed after 14-21 days). This treatment is maintained for another 3-4 months and is then replaced by medical compressive stockings, anti-thrombotic creams and gels and oral Detralex. Even though this good surgical management, we could notice a 30% rate of recurrences during the next two years after treatment.
Treatment of a 57 years old male patient with an extended ulcus cruris of the left leg. Preparation of the wound bed with LIGASANO® white, afterwards tangential excision and skin grafting. Wound healing takes place within eight weeks.

Fig. 4.6.2.13

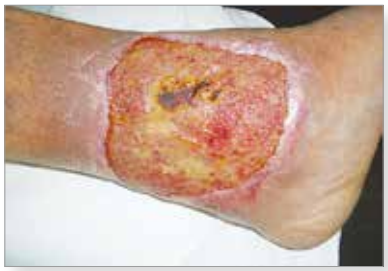


Fig. 4.6.2.14

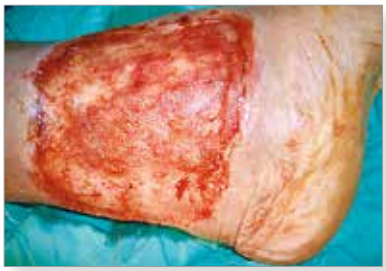


Fig. 4.6.2.15

4.6.3 Diabetic Foot Ulcer

Due to the expert standard "Care of People with Chronic Wounds", in Germany more than 6 Millions of people were medicated with the diagnosis „diabetes mellitus". Because more and more diabetics live always longer with their disease, thus the diabetes-caused late damages have increased.
The **long-term diabetic syndrome** may become manifest in **micro-angiopathy** (diabetic nephro- and retinopathy, somatic micro-angiopathy), **polyneuropathy** (sensorimotoric and autonomic neuropathy, mono-neuropathy) and **macro-angiopathy** (coronary sclerosis/ischaemic heart disease, cerebral sclerosis/chronic venous insufficiency) and leads to the diabetic foot syndrome. In the last decades the diabetic foot develops to a focal point in the diabetic treatment, which is a considerable cost factor with at least 20% of the whole therapy expenditures.

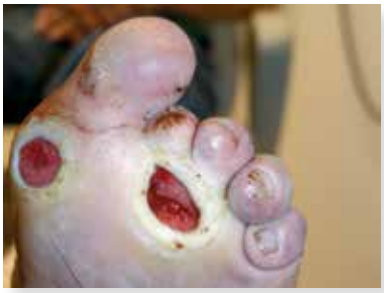


Fig. 4.6.3.1

Types of the diabetic foot lesions are

- the infected neuropathic foot
- the ischaemic-gangrenous foot at peripheral arterial occlusive disease
- the infected foot at diabetic polyneuropathy and peripheral arterial occlusive disease
- foot infection at bad diabetic metabolic status without a proved relevant neuro- or angiopathy

Fig. 4.6.3.2

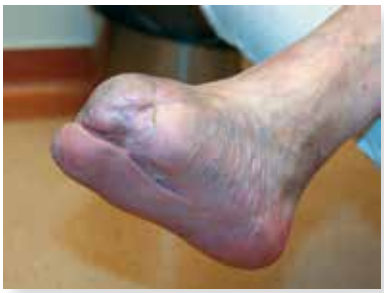


Fig. 4.6.3.3

The treatment of a diabetic foot lesion needs patience and expert knowledge. The therapy of the basic disease, i.e. stabilisation of the diabetes for example with an intensified insulin therapy, increases the efficiency of the anti-infective treatment and decreases the secondary increase of blood lipids, especially these of the viscosity elevating LDL as well as fibrinogen. Further you have to relieve the ulcer or gangrene.
An initial exhaustive wound cleaning and sanitation of the wound area is the quickest and safest way to control the infection and to sanitate the wound. In most cases this is made by chirurgical debridement as well as physical debridment using special wound dressings. Conditioning and composition of granulation tissue and afterwards epithelisation tissue is effected with moist wound treatment.
To prevent this lesions, the patient has to be urged necessarily to care and especially to daily inspections of his feet. "The life-long implementation of structured measures for prevention of recurrence by control of the afflicting causes is therefore an integral part of the successful support of patients with diabetic feet" (Hochlenert D, Engels G, Morbach S, Das diabetische Fußsyndrom, 2014)

Classification of foot ulcerations according to Wagner / modified according to Armstrong

	0	1	2	3	4	5
A	Pre- or post-ulcerated foot	Superficial wound	Wound up to joint capsule, tendon, bone	Wound up to bones and joints	Necrosis of a part of the foot	Necrosis of the whole foot
B	With infection	With infection	With infection	With infection	With infection	With infection
C	With ischaemia	With ischaemia	With ischaemia	With ischaemia	With ischaemia	With ischaemia
D	With infection and ischaemia	With infection and ischaemia	With infection and ischaemia	With infection and ischaemia	With infection and ischaemia	With infection and ischaemia

Table 4.6.3.4 (translated) from: S3-Leitlinie 091-001 „Lokaltherapie chronischer Wunden bei den Risiken CVI, PAVK und Diabetes mellitus.

The excerpt of a study regarding the use of LIGASANO® white as primary wound dressing at diabetic foot lesions by Dr. med. Carola Zemlin, internist/diabetologist, shows possibilities for the treatment. The article is also published in the professional journal "Lazarus" (year 16, issue 18, Sept. 2001, page 24).
„The diabetic foot syndrome undoubtedly belongs to the most grave complications of diabetes: a high rate of amputations, high costs for the health insurance and increased extra charges for the persons concerned, long stay in hospitals, loss of working hours and/or early invalidism, to be dependend on outside help, immobility, restricted participation on social life, frustration, despair – this all we associate with the problem "diabetic foot" for the present. As a result of published experience of diabetic-foot-ambulances in the USA, in England and Scandinavia, there is rethinking also in Germany.

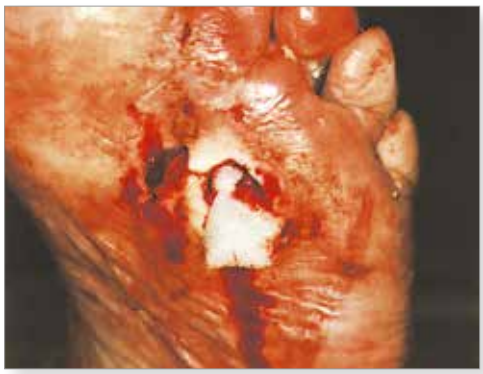


Fig 4.6.3.5

It shows that interdisciplinary care concepts, structured diagnosis and therapy, as well as "lifelong foot care" in the case of high risk patients can improve the situation, described at the beginning, significantly. On the one hand it is important to throw overboard obsolete doctrines and clichés ("diabetic feet don´t heal or only heal badly, therefore amputating them rather high") as well as unsighted, expensive(!) polypragmasis of local wound healing and inadequate orthopaedic shoe technique.
On the other hand you have to seek for effective, biologically well tolerated and economy-priced wound dressings at the same time for treating as much patients as possible without cost pressure. The following contribution deals in a broad sense with the wound treatment on patients with diabetic foot lesions and in a narrow sense with the application of LIGASANO® foam dressings in wounds and wound healing impairments respectively, of the above mentioned patients.

1. Patients and Methods:

In the period from March 1998 until January 2000 we have treated 15 patients (12 male, 3 female) with an average age of 54 years. Listed were:

- Kind of lesion:
  wound healing impairment after amputation/resection, ulcera of the heels, malum perforans, wounds after sequestrum cut by diabetic neuro-osteo-arthropathy (= DNOAP, syn. Charcot´s syndrome)
- Extend of the wound (WAGNER stage) and wound phase
- Classification according to ARLT (A=peripheral arterial occlusive disease, B=polyneuropathy, C=A+B=mixed type)
- Duration of the wound
- Methods of preliminary treatment
- Days of hospital stay during prelininary treatment
- Proceeded amputations on the same or contralateral leg
- Days of hospital stay during the current treatment
- Methods of the current treatment
- Number of the ambulant consultations
- Duration of healing under the current therapy
- Dressing change

Apart from tabular charts there were made detailled case descriptions with photo documentations about every treated patient.

Dates of patients / Case histories

Number of patients	15
Age of the patients	Average age 54 years (41 - 69)
Sex of the patients	12 male, 3 female
Diabetes diagnosed since	Average 17 years
Amputations before starting the treatment	3 patients with amp. of the lower leg 9 patients with amp. of the toes
Further planned amputations	For 6 patients lower leg
Duration of treatment before	Average 300 days (0 - 1095)
Days thereof as an inpatient	Average 74 days (0 - 270)
Result of the treatment	No wound healing
Estimated cost of treatment	
Average outpatient	226 days à 30 € = 6780.00 €
Average inpatient	74 days à 270 € = 19980.00 €
Average total	**26760.00 €**

Treatment by Dr. Zemlin with LIGASANO® white

Duration of treatment	Average 90 days (18 - 450)
Days thereof as an inpatient	0 days
realised/necessary amputations	None
Result of the treatment	Wound healing
Cost of treatment	
Average outpatient	90 days à 30 € = 2700.00 €
Average inpatient	0 days à 270 € = 0.00 €
Average total	**2700.00 €**

Tab 4.6.3.6

2. Results and Summary:

The results (see table) speak for themselves. There was no need to provide information on lack of work, because all patients were already retired or disabled.

I have used LIGASANO® white foam dressing since already 1994 for wound treatment. The material was first introduced to me by Mr. Rettig, a nurse and enthusiastic wound therapist from Lüchow-Dannenberg, Germany. Little by little I have recognised and appreciated the multi-purpose possibilities of LIGASANO®. It has excellent qualities as padding material over regions with a high pressure load (heels, edges of feet, plantar at malum perforans, interdigital, toe-tips) and is very helpful for the soft debridement. In doing so LIGASANO® white is soaked with Ringer®´s solution and then the wound will be cleansed. Due to the high frictional resistence of LIGASANO® white, necrotic layers and detritus of cells are removed from the wound gently. The debridement with a sterile toothbrush, as recommended in some literature, is superfluous.

We use LIGASANO® white as a primary wound dressing for about two years and were surprised of its stimulating effects in secretion and granulation! And precisely in deep wounds LIGASANO® white is obviously superior to alginates and hydrocolloides, above all as a result of its additional capillar effect.

For the application of LIGASANO® white in deep wounds we cut the material in various sizes and shrink-wrap it. Subsequently the stripes are going to be sterilised by steam and distributed for the home-care. If the dressing is not changed by nursing stuff but by the patient or his relatives, we prescribe sterile one-way tweezers.

Finally we use LIGASANO® white also as a secondary wound dressing for padding over every wound dressing, as it is the uppermost layer, because a soft drainage pressure and warmth is also necessary for wound healing. For this purpose LIGASANO® bandages are best qualified for.

Beside the above mentioned multi-purpose application possibilities of LIGASANO®, the comparatively low costs of this material are a further great advantage! For this reason LIGASANO® white belongs to our foot ambulance as an unrenouncable part of dressings.

Treatment example:

58 years old, female, type 2 diabetes mellitus, duration of 22 years, dialysis since 1994 because of diabetic nephropathy, laser coagulated retinopathy, insulin therapy 3x normal at night NPH insulin, coronary heart disease, cardiac disrhythmia.

In 1992 resection of the 2nd left metatarsal bone because of a perforating ulcer of the foot; at that time this is healed completely. On 05/05/1998 first visit in our ambulance by reason of a 26 month old recurrent perforating ulcer of the right foot with projection to the 3rd metatarsal bone. Hitherto hospital stay 81 days without drastic improvement. No decompression measures took place. The amputation of the lower leg was advised.

Local pre-therapy:

Ointment containing chlorophyll, irrigation with H_2O_2 solution and hypertonic NaCl solution, antiseptic gauze. Change of dressing two times daily by nursing service, referral by the dialysis practice.

Actual findings on 05/05/1998:

Distinct prominence of the forefoot, plantar, bilateral, claw toes, arterial pulses strong, dry and scaly skin, hypallaesthesia, sensibility for temperature and pain lapsed, no provocation of patellar and achilles reflex; indolent ulcus, plantar, 1.6 x 1.1 cm with a depth of 2 cm; the exploring forceps breaks into crumbled struc-tures. Resection of bone and cartilage debris with a bone curette and Luer´s bone nibblers, irrigation with Oxoferin®, inlay with a sterile LIGASANO® white pack, cut to fit, which is changed once daily and soaked with Ringer®´s solution, and over this a mull dressing. Because fixative bandages are not tolerated by the patient, we fix the dressing with hypoallergenic plaster.

Adequate instruction of the very cooperative patient, which on her part informs the nursing service.

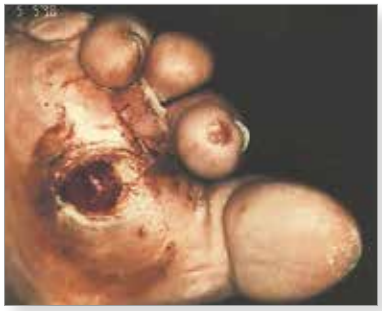


Fig. 4.6.3.7: findings on 05/05/1998

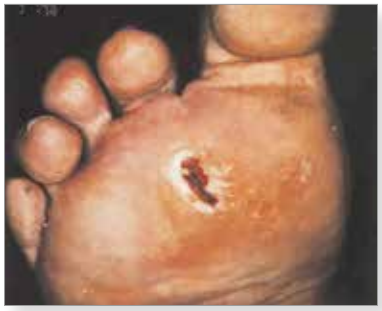


Fig. 4.6.3.8: wound control on 07/07/1998

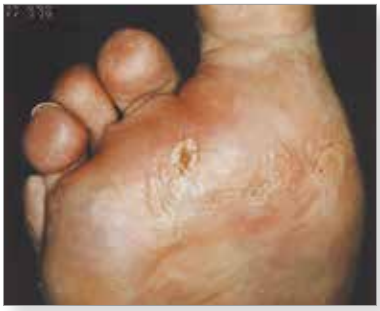


Fig. 4.6.3.9: August 1998

We provide her with sterile LIGASANO® white packs (cut to fit, sterilised with steam and heat-sealed in our ambulance). Decompression: decompressive bandage shoe. During wound inspection on 14/05/1998 measurement for orthopaedic foot wear. Already on 07/07/1998 remains only a very plain wound.

4.6.4 Pre- and Post-Surgical Wound Treatment

The wound treatment is made according to the kind of wound and its size (examples for filling and covering of the different wound types see pages 45-46). In case of bleeding wounds please pay attention to moisten LIGASANO® white previously with Ringer® solution or similar, because otherwise LIGASANO® may stick to the wound. Especially in case of postsurgical wound healing disturbances LIGASANO® white is the remedy you should choose.

Treatment example 1:
Fig. 4.6.4.1 to 4 show, how a wound in the inguinal region (state after abscess removal) with a depth of 3 cm and a wound undermining to medial 8 cm, is dressed with LIGASANO® white.

Fig. 4.6.4.1

Fig. 4.6.4.2

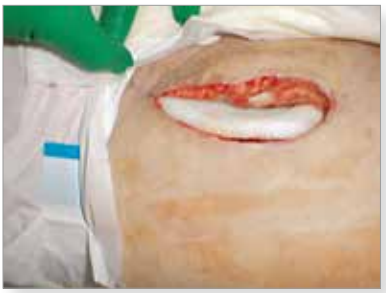


Fig. 4.6.4.3

In this case we decided for LIGASANO® white with a thickness 1 cm to tamponade respectively fill the wound. Alternatively you can work with the LIGASANO® white wound strip, too. The wound was covered with LIGASANO® white with a thickness of 2 cm and fixed with an elastic bandage.

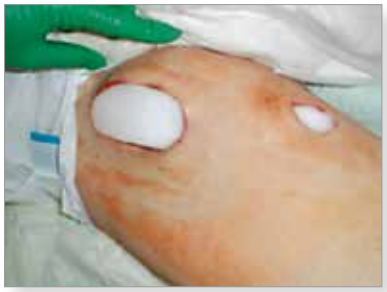


Fig. 4.6.4.4

Fig. 4.6.4.5

After two days LIGASANO® white was changed, because its absorptive capacity was exhausted. LIGASANO® white allows to be removed from the wound atraumatic and without pain (fig. 4.6.4.5.).

Treatment example 2:
The therapeutic effect of LIGASANO® white was shown especially at the care of abdominal, postoperative wound healing impairments. During the phase of secretion LIGASANO® white was changed once daily, until the bottom of the wound was clean and began to granulate. In the second phase of the wound healing the dressing was changed once every two days. We paid attention that there was no adhesion between dressing and the new constituted tissue.

Fig. 4.6.4.6

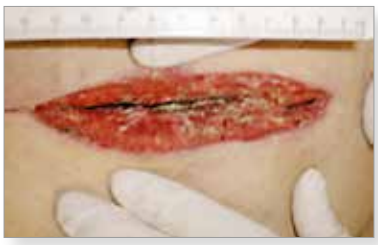


Fig. 4.6.4.7

Fig. 4.6.4.8

From fig. 4.6.4.6 to 4.6.4.8 three weeks passed. Additional to the therapy with LIGASANO® white the wound edges were adapted during the phase of granulation with suture plaster, to reduce the wound furthermore in size and to achieve a good cosmetic result.

4.6.5 Burns, Scalds, Congelations

A burn is a traumatic damage of the skin by the effect of heat (flames, liquids, electricity). The treatment of the burned wound goes by its depth and dimension. The dimension of a burn is indicated by the part of the affected skin in relation to the body surface in percent. Large-area burns, that means from 20% of the body´s surface on (adults and children) respectively 5% at infants, are a vital threat. By means of the so-called **niner rule** the dimension of burns can be estimated (see table 4.6.5.1).
At children under 8 years and infants you have to use age-adjusted values.

	Adults	Children	Infants
Head	9 %	14 %	18 %
Torso	2 x 18 %	2 x 18 %	2 x 18 %
Arms	2 x 9 %	2 x 9 %	2 x 9 %
Legs	2 x 18 %	2 x 16 %	2 x 14 %
Genitals	1 %		

Tab. 4.6.5.1: partitioning of the body surface according to Wallace´s niner rule

The profundity of burns is classified in three degrees of severity and results of the depth of the damaged skin:

Grade I: painful erythema as a result of oedema of the epidermis and hyperaemia of the corium.
Prognosis: spontaneous healing without scarring.

Grade II: in case of second-degree burns also the dermis is damaged. It is further classified in superficial (2a°) and deep (2b°) burns.
IIa°: the epidermis is destroyed until the superficial corium layer, cutaneous appendages (hair, nails) and glandulas are preserved and intact. Formation of blisters caused by albuminous exudation of liquid between corium and epidermis.
Prognosis: spontaneous healing without scarring.
IIb°: at deep second-degree burns the damage goes up to the deep layers of the corium, with a distinct reduction of sensibility and beginning circulatory disturbance of the subcorial dermal vascular net.
Prognosis: healing with scarring, depending on its extension in the depth. Possibly surgical wound treatment and transplantation is necessary.

Grade III: subdermal burn, combustion necrosis of all layers of epidermis and dermis including cuteaneous appendages. White-brown or black discolouration of the often leather-like skin. The sensibility is completely lapsed, because the nerve endings, which are lying under the skin, are burned.
Prognosis: in the case of third-degree burns a spontaneous healing is hardly possible. Surgical excision and wound covering with skin grafts is mostly not avoidable.

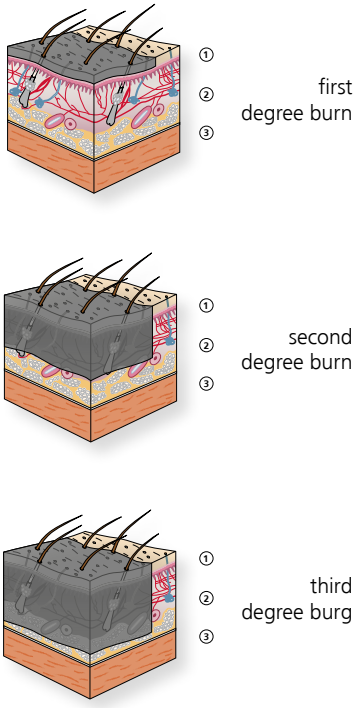


Fig. 4.6.5.2: degrees of burn
1) epidermis; 2) dermis; 3) subcutis

The burn wound itself is classified again in three zones, the hyperaemic zone **(1)**, the zone of the stasis **(2)** and the coagulation zone **(3)**.
The coagulation zone is the central part of the burn wound. The whole area is characterised by denaturation and necrosis; there is no blood circulation. The tissue is no more able to regenerate itself.

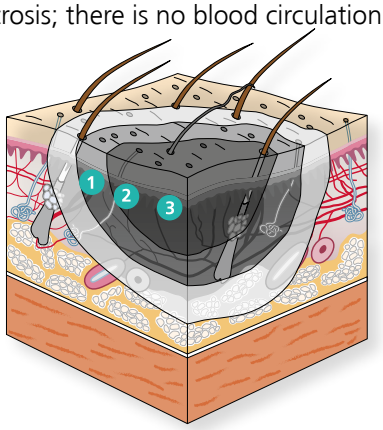


Fig. 4.6.5.3: burn zones (according to Jackson)

The zone of the stasis follows directly the coagulation zone. Here metabolism and blood circulation are highly constricted. Initially the cells are still active, but if the stasis continues for a longer time, the cells may collapse, caused by vasoconstriction, swelling of endothelial cells, platelet thrombus, fibrin deposition, amongst others. Further damage of this zone, caused e.g. by pressure or infection, may lead at any time to change to the coagulation zone. The hyperaemic zone is localised at the exterior border of the burn wound and appears as a red zone. With pressure the tissue colours to white, and becomes red at decompression again. Microcirculation and metabolism are defective, the cells of this zone are hardly destroyed and the tissue is able to regenerate itself completely.

Therapeutic advantage of LIGASANO® white for the treatment of patients with heavy burn injuries:
Because of its therapeutic effects LIGASANO® white is used in several burn centres for cleaning and conditioning of burn wounds before surgical treatment. For this see also chapter 4.6.6. (page 64): wound conditioning before surgical treatment.

Treatment example 1:
41 years old, male, extensive full-thickness circumferential flame burn of the right lower limb; tangential excision followed by passive debridement with LIGASANO® white and skin grafting. Complete healing within two months.

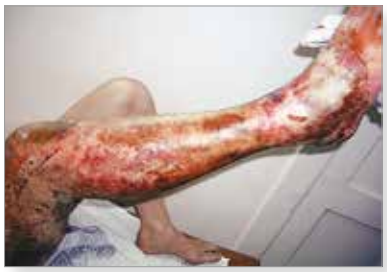


Fig. 4.6.5.4

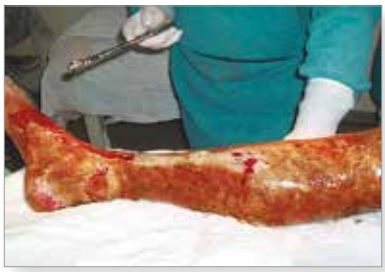


Fig. 4.6.5.5

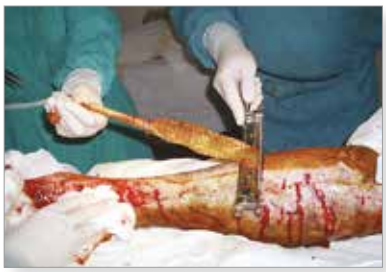


Fig. 4.6.5.6

Fig. 4.6.5.7

Fig. 4.6.5.8

Fig. 4.6.5.9

Treatment example 2:
76 years old, female, with full-thickness hot liquid burn of the left axilla, shoulder, arm and breast, severe cardiac failure and other cardiovascular problems; passive debridement with LIGASANO® white, followed by split-thickness skin graft (STSG). Complete healing in about two month.

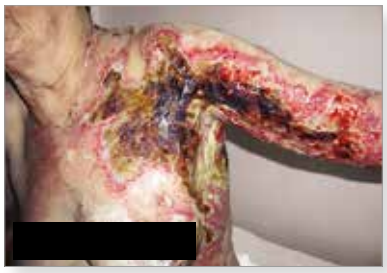


Fig. 4.6.5.10

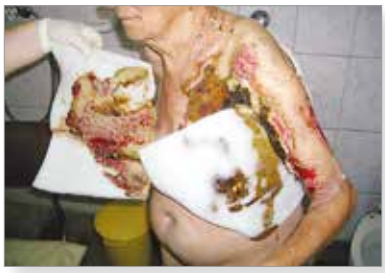


Fig. 4.6.5.11

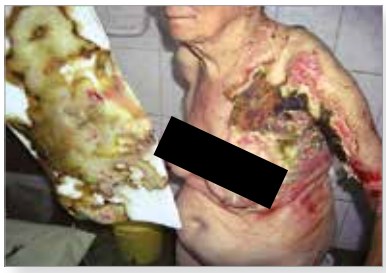


Fig. 4.6.5.12

Fig. 4.6.5.13

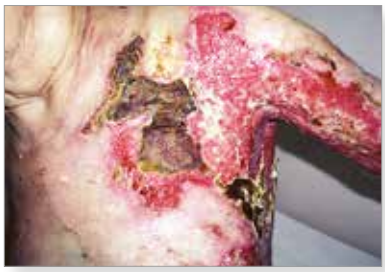


Fig. 4.6.5.14

Fig. 4.6.5.15

Treatment example 3:
38 years old, male, with third degree frostbites at both feet; inpatient for three days, then treated as an outpatient.

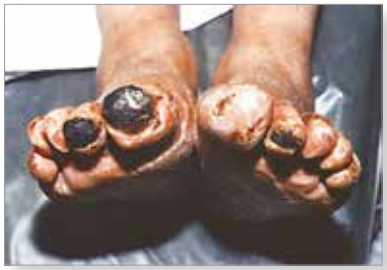


Fig. 4.6.5.16: condition before treatment with LIGASANO® white

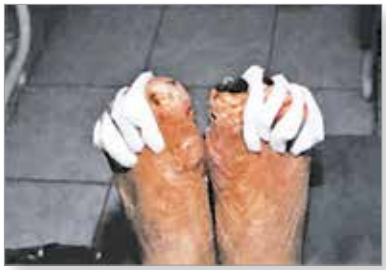


Fig. 4.6.5.17: treatment with LIGASANO® white wound dressing

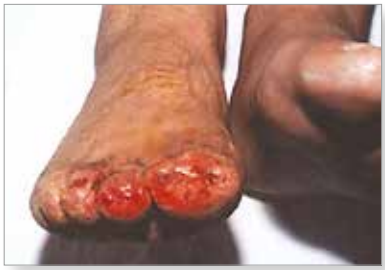


Fig. 4.6.5.18: wound condition after surgical debridement

Fig. 4.6.5.19: treatment with LIGASANO® white wound dressing

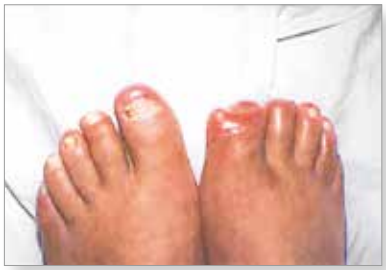


Fig. 4.6.5.20: condition after three months of treatment

4.6.6 Conditioning of Wounds before Surgical Intervention

According to Dr. Adrian Botan, the passive debridement with the polyurethane foam LIGASANO® white has all the advantages of maggot therapy but none of its disadvantages, that is why he calls this method "synthetic maggot therapy". Because of its special structure and properties, LIGASANO® white shows the following modes of action:

- Wound activation by mechanical stimulation (micromasage) of the lesion surface and surrounding tissues, improving the blood and nutrients supply of the complete area
- Reduction of pressure on the wound surface which facilitates collagen deposition and granulation
- It absorbs a high amount of exudate and debris
- Improves the cost/efficiency ratio by avoiding expensive surgical techniques, decreasing the inpatient period and the frequence of dressing change, and decreasing the total treatment cost as well by improving the social and professional reconnection of the most part of patients treated in this way.

Treatment example:
72 years old paraplegic male patient with a huge neglected sacral sore.

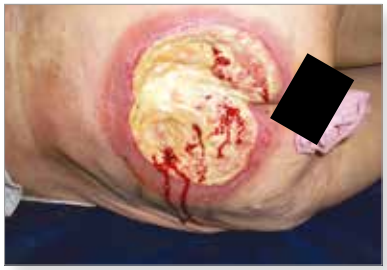


Fig. 4.6.6.1: initial aspect, before any treatment with LIGASANO® white

Fig. 4.6.6.2: LIGASANO® white with a thickness of 2 cm is applied multilayered (3-4 layers of foam) and covered with sterile gauze paddings.

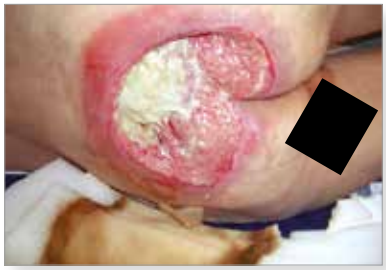


Fig. 4.6.6. 3: the dressing has been replaced every week because the patient couldn´t come more frequently to the office for a new dressing. At least one half of the huge pressure sore has been debrided and granulated after 4-5 weeks of treatment with LIGASANO® white.

Fig. 4.6.6.4: in order to compare two PUR foams, LIGASANO® white was replaced with another foam, but after two such dressings, we had to return to LIGASANO® white, because the other has had to be replaced at least three times a week. Beside this, the debridement was not as effective like that with LIGASANO® white.

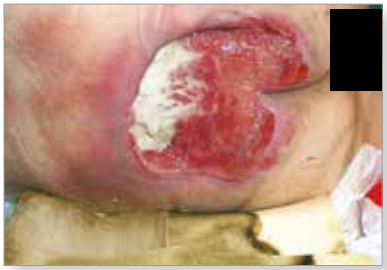


Fig. 4.6.6.5: after two weeks of treatment with LIGASANO® white again, the most part of the eschar disappeared and the bottom of the large wound was filled with very good granulation tissue.

4.7 LIGASANO® green and LIGASANO® orange as Wound Dressings and Wound Filler

LIGASANO® green and LIGASANO® orange are elastic, expanded polyurethanes (PUR), which are almost always pervious to air and liquids (e.g. water) - imagine a three-dimensional sieve. They have a coarse texture and rough surface.
LIGASANO® green and LIGASANO® orange are used for wound treatment and care, if strength and elastic materials with high permeability to air and liquid are required.
The surfaces of LIGASANO® green and LIGASANO® orange are relatively rough. If they are used in wounds or on skin, lesions may occur, especially by friction.

4.7.1 General Information for Application:

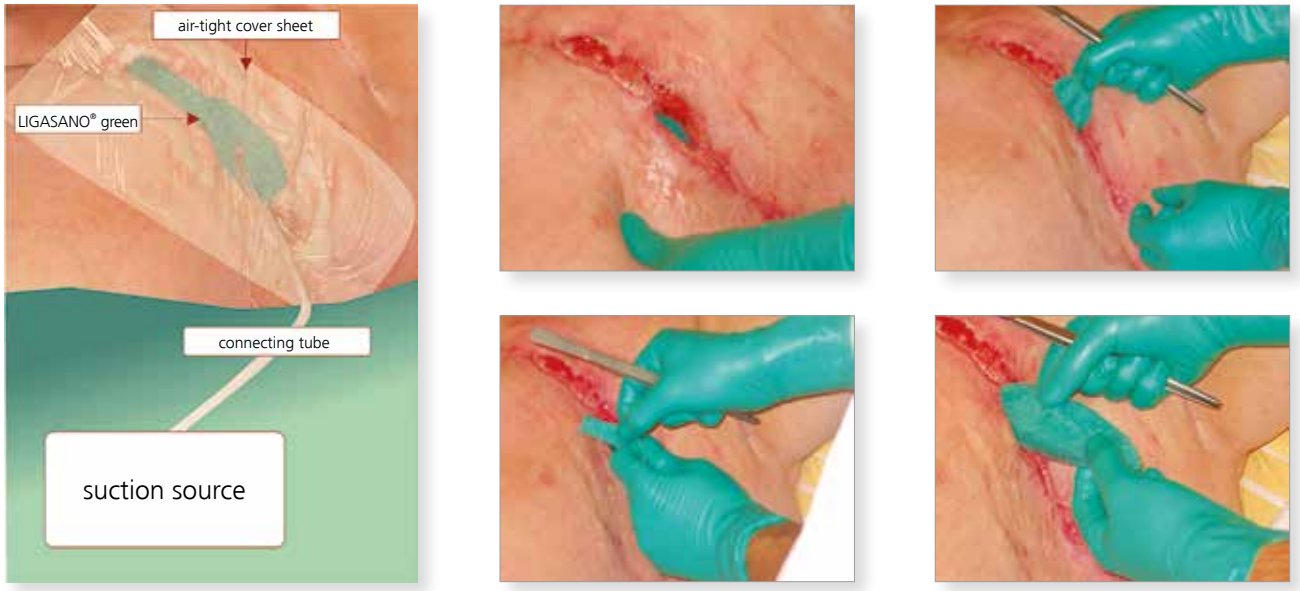


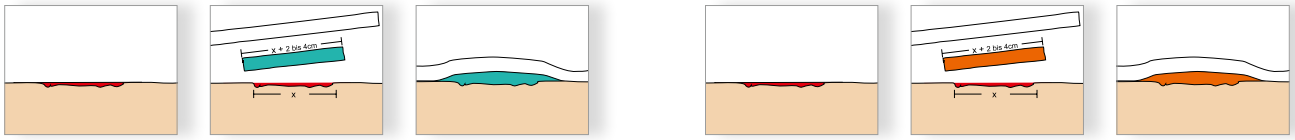
Fig. 4.7.1.1 - 4.7.1.5: the use of LIGASANO® green as a wound filler in NPWT

- With LIGASANO® green and LIGASANO® orange you can cover or fill wounds. It countervails a collapse of wounds by effect of external pressure or suction, e.g. during an active wound drainage resp. NPWT.
- By the special properties of its surface a mechanical stimulus is caused on the area of contact, favouring the blood flow, and hence stimulates in case of contaminated or infected wounds the normal body reaction "wound cleaning by secretion". Moreover the transportation of substances should be stimulated hereby in the wound and so effects a promotion of granulation. This active principle is known and approved since decades by LIGASANO® white.
- You can apply LIGASANO® green and LIGASANO® orange also on skin, especially in the wound area. Thus you can utilise the above described mechanical stimulus on a greater area to stimulate the wound healing (see page 31-32).

- By the described open structure of LIGASANO® green and LIGASANO® orange wound irrigations are possible in spite of the filled wound.
- A drainage of exudate, irrigation etc., following the gravitation down out of the wound is made possible.
- LIGASANO® green and LIGASANO® orange is able to be combined with LIGASANO® white in some cases of application.
- A combination makes sense if e.g. a considerable quantity of exudate has to be subdued, which exceeds the absorption capacity of LIGASANO® white.
- At urinary incontinence an urinary outflow should be made possible within the usual incontinence care with a common underlay or trousers, down, away from the skin, so that the skin is protected against these excrements.
- **The decision about the particular kind of application of LIGASANO® green and LIGASANO® orange is determined by medic or medically trained personnel and is adapted and appropriated in every single case.**

4.7.2 Application on Different Kind of Wounds

Skin-deep wound (ul to a depth of 0.5 cm)

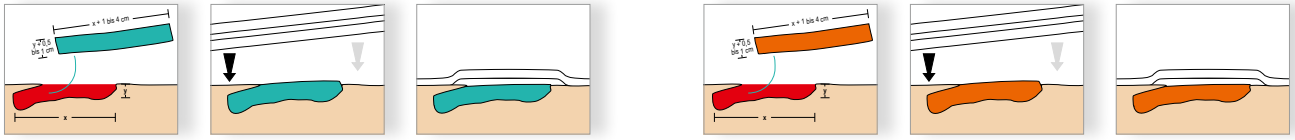


- Complete covering of the wound wit LIGASANO® green or LIGASANO® orange
- Observe that complete contact with the wound is also insured on deeper locations of the wound
- Cover with LIGASANO® white or an other absorbing dressing
- Air-permeable fixation

Deep wound

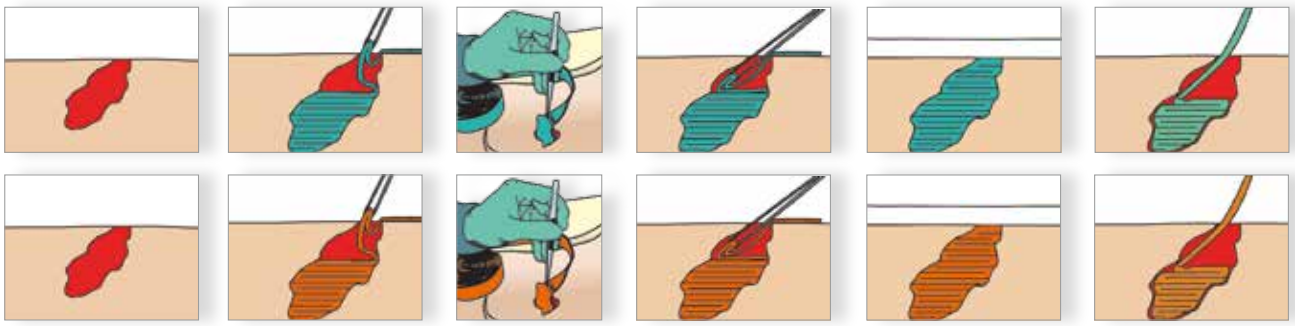
- Complete covering of the wound wit LIGASANO® green or LIGASANO® orange
- There must be complete contact to the wound everywhere, also at the wound edges
- Cover with LIGASANO® white or an other absorbing dressing
- Air-permeable fixation

Deep wound with undermining



- Completely fill the undermining and the wound with LIGASANO® green or LIGASANO® orange
- There must be complete contact to the wound everywhere, also at the wound edges
- Cover with LIGASANO® white or an other absorbing dressing
- Air-permeable fixation

Wound with narrow opening / fistulae



- Fill the wound completely with the cavity dressings LIGASANO® green or orange wound strip, mini wound strip, or micro wound strip (depending on the volume of the wound). Firstly explore direction and depth of the wound, so that you can reliable reach the bottom of the wound.
- There must be complete contact to the wound everywhere, also at the wound edges
- Cover the wound and the wound environment with LIGASANO® white or an other absorbing dressing
- The wound strip should assume a zigzag pattern in the wound. Almost no friction is generated when extracting the strip from the wound. Dressing change is quick, easy and with relatively little pain. A premature, superficial closure of the wound will prevented.
- Air-permeable fixation

4.7.3 Risks and Side Effects, Contraindications:

Wound cleaning: mechanical debridement may cause pain, even with LIGASANO® green sterile or LIGASANO® orange sterile.

Wound treatment: because of its cell structure a vascularisation (e.g. of granulation tissue) into the material is possible. You can prevent this with a timely dressing change, after 1-4 days using LIGASANO® green sterile or LIGASANO® orange sterile. On passive wounds or parts of the body that receive poor blood supply, pain may occur after application. This occurs when the blood circulation is stimulated by the mechanical stimulus of the material to such an extend, that previously diminished or reduced pain returns. Initially the pain can be intense, however it is usually regulated after a few hours to days. If this effect is not desired, you should forgo its application. In case of an "open wound care" without additional cover you have to take into consideration that there exists barely protection against the ambient atmoshpere. Too much pressure due to the material´s prior tension, external influence, or suction may lead to compression of vessels and therefore to pressure ulcers.

If hypergranulation occurs, please treat it appropriately and switch to other dressing material groups, if necessary. LIGASANO® green and LIGASANO® orange are a very simple products and the effects are due to the structure. They do not contain nor emit any active compounds. With the correct application of LIGASANO® green and LIGASANO® orange there are no known negative side effects, nor incompatibility or interactions with medicine. Typical side effects may include reddening of the skin upon contact and initial "itching". More intense side effects may include return of sensitivity due to stimulation of local blood circulation. Its effects are only physical and end almost immediately after discontinuation of application. As with all wound dressings, minor skin reactions such as maceration, erythema, secondary infected dermatitis, erysipelas as well as hypersensitivity reactions and pain at dressing change may occur.

Please report any incidents that have occurred in connection with our dressing materials LIGASANO® green sterile or LIGASANO® orange sterile to us or to the competent authority of the member state in which the incident occurred.

Contraindications: tumour wounds and untreated osteomyelitis. Not suitable for contact with organs, contact to exposed blood vessels or anastonimic areas with the danger of damage, or contact with nerves.

4.7.4 Dressing Change Intervals

LIGASANO® green sterile and LIGASANO® orange sterile are suitable for single use only. Sterility is ensured only by intact package. The products must not be used after the expiration date and are not suitable for reconditioning or resterilisation due to its potential for contamination.

LIGASANO® green sterile and LIGASANO® orange sterile must not continuously remain in the wound or on the body. The application may be repeated over a period up to 30 days, always with a new device. Dressing change after 1-4 days, depending upon the indication. Please consider that LIGASANO® green sterile and LIGASANO® orange must not have direct contact to organs, exposed blood vessels, anastonomic areas or nerves. They may have direct contact to mucosa.

4.7.5 Examples of Wound Treatment

Treatment Example 1

81-year-old mobile patient, female, condition following a fall on the left knee and lower leg with subsequent pronounced haematoma. After about two weeks, swelling in the distal lateral area of the lower leg and coarse tissue resistance to about 15 x 10 cm. The patient was presented to surgery. Therapy order: Hepatroma ointment dressing. In the further course, a dry, then later a moist necrosis was demarcated in this area. Surgical presentation as an outpatient on 22/02/2017 for debridement. Secondary finding: CVI stage 1 according to Widmer; condition after osteosynthesis after a fracture of the femoral joint several years ago. This also leads to a tendency to oedema and a slight restriction of movement of the femoral joint.

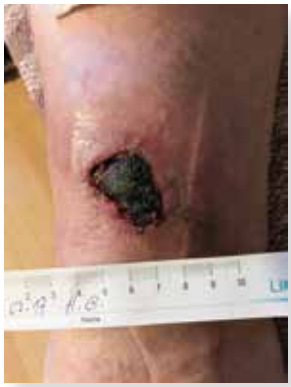


Fig. 4.7.5.1.1: 17/02/2017, wound size 2.0 x 3.0 cm, depth cannot be determined

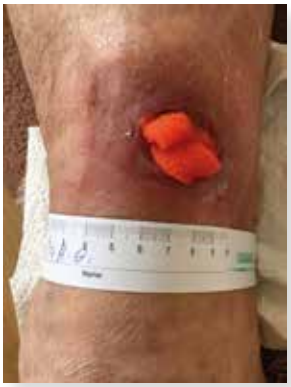


Fig. 4.7.5.1.2: 25/02/2017, first mechanical debridement with LIGASANO® wound cleansing sponge medium.

Fig. 4.7.5.1.3: 25/02/2017, wound condition after wound clenasing, size of the wound 2.5 x 3.0 x 1.5 cm

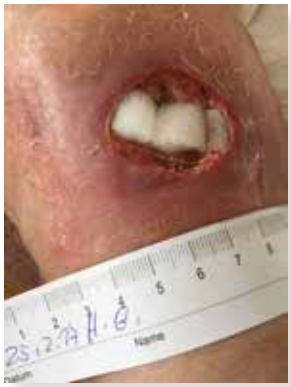


Fig. 4.7.5.1.4: 25/02/2017, wound filler (tamponade, cavity dressing) made of LIGASANO® white sterile wound strip

On 25/02/2017 the wound size was 2.5 x 3.0 x 1.5 cm, undermining to tibial 1.5 cm, to dorsal 1.8 cm. Dorsally spongy necrotic tissue/coagulum, tibially appears firmer structure, exudate moderate, bloody, no wound odour. Wound environment livid, edema well regressed under the light compression.
Wound cleansing with LIGASANO® wound cleansing sponge for cavities medium in combination with Prontosan W; wound filler: LIGASANO® white sterile cavity dressing (wound strip micro); wound dressing: LIGASANO® white sterile compress 10 x 10 x 1 cm.
Fixation: Tubifast and short tension bandage with slight compression. Dressing change once daily.
The dressing is left on at night and is well tolerated. The patient reported hardly any pain, short-term mild pain during wound cleansing.

On 05/03/2017 the wound size was 2.5 x 3.5 x 1.5 cm, undermining to tibial 3.0 cm, to dorsal 3.0 cm. As far as can be seen, necrotic tissue/coagulum rejected, wound bed moderately fibrinous, after tibial clear increase of the fistula. Exudate moderate, less bloody, no wound odour. Wound environment livid without signs of infection. Therapy recommendation continues with LIGASANO® white sterile wound strip/tamponade and LIGASANO® compress as secondary wound dressing, for the wound bed Repitel wound gel.

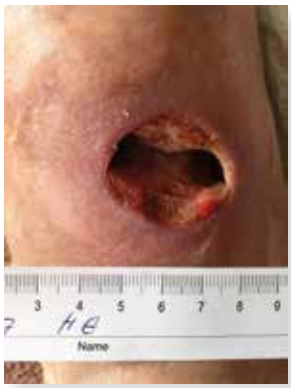


Fig. 4.7.5.1.5: 05/03/2017 wound condition after mechanical debridement with LIGASANO® wound cleansing sponge medium

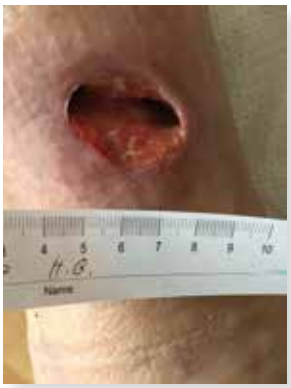


Fig. 4.7.5.1.6: 23/03/2017 wound condition afterwound cleaning with Prontosan wet phase

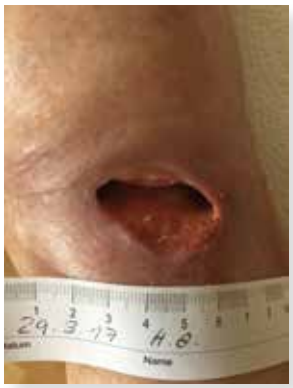


Fig. 4.7.5.1.7: 29/03/2017 wound condition afterwound cleaning with Prontosan wet phase

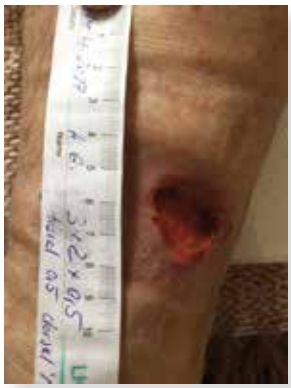


Fig. 4.7.5.1.8: 14/04/2017 Irritated wound environment after approx. one week of application of an alginate tamponade

On 23/03/2017 the wound size was 2.5 x 3.5 x 1.5 cm, undermining to tibial 2.5 cm, to dorsal 2.0 cm. As far as can be seen, wound ground without coatings and good tendency for granulation end epithelisation, not completely viewable to tibial. Exudate moderate, subtle bloody, no wound odour, wound environment intact, moderate oedema.

On 29/03/2017 the wound size was 2.0 x 3.0 cm x 1.3 cm, undermining to tibial 2.5 cm, to dorsal 1.5 cm, exudate moderate, subtle bloody, no wound odour, wound environment intact, moderate oedema, daily dressing change.

First, the wound dressing structure is unchanged. From 05/04/2017 on, the wound filler was replaced by an alginate tamponade (the surgeon insisted on the use of alginate) and LIGASANO® white sterile compress as wound dressing. Dressing change was still daily.

On 14/04/2017 a grat amount of bloody exudate, the wound area appears irritated, reddened and slightly inflammatory. Sorbalgon discontinued for test.

On 18/04/2017 the wound size was only 1.5 x 2.8 x 0.3 cm, significant improvement under the therapy with Repithel Gel and LIGASANO® white; protection of the wound edge with Dline Zinc cream. Exudate moderate, no longer bloody, no wound odour, wound environment less irritated, significant reduction of the wound area, good granulation and epithelisation.

From 03/05/2017 on the secondary dressing was changed to Mepilex postop.

In the course of the therapy, the dressing change interval was adapted up to three times dressing change weekly.

The concomitant therapy was a change to a two-piece stocking system of compression class 2 in order to reduce the oedema and allow the patient the greatest possible mobility.

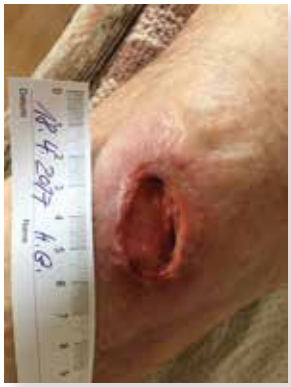


Fig. 4.7.5.1.9: 18/04/2017, the fistulae are almost completely closed.

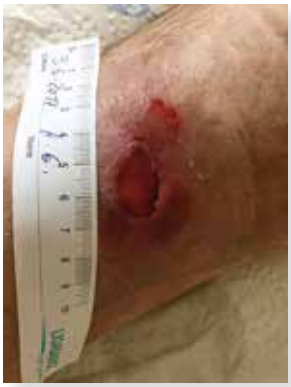


Fig. 4.7.5.1.10: 03/05/2017, fistulae completely closed, further reduction of the wound area.

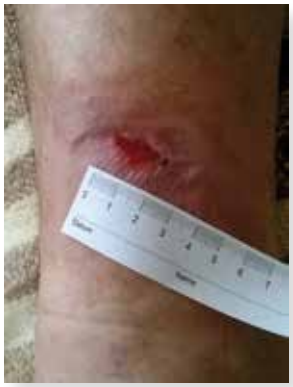


Fig. 4.7.5.1.11: 29/05/2017, the wound ist almost completely epithelised.

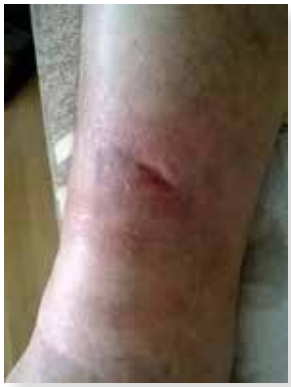


Fig. 4.7.5.1.12: 23/06/2017, the wound is completely healed with very good cosmetic result.

Conclusion:
The application of LIGASANO® orange (wound cleaning sponge medium) leads to a clean wound, thus the therapy time was shortened. LIGASANO® white as wound dressing has proved to be very effective in this wound care and has prevented damage (maceration) of the wound environment to a large extent due to its good drainage effect.

Treatment Example 2

66 years old patient, male, beginning liver cirrhosis, no other underlying diseases. The cause of the ulcer is unclear, an autoimmune disease is suspected. The therapy with LIGASANO® green started already in the hospital.

On 29/10/2020, the patient received initial care at home by Medical-Center Südwestfalen GmbH & Co KG, Freudenberg, Germany.
The wound was treated as follows:

- Wound cleansing with Polyhexanid solution and sterile compresses
- LIGASANO® green as primary wound dressing
- Superabsorbent dressing as secondary wound dressing
- Followed by compression bandages

Daily dressing change because of heavy exudation.

Once a week, a wound visit was carried out by Jenny Maßfeller from the Medical Centre Südwestfalen. The daily dressing changes were carried out by a local outpatient nursing service.

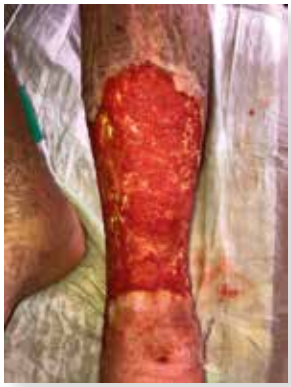


Fig. 4.7.5.2.1: 29/20/2020

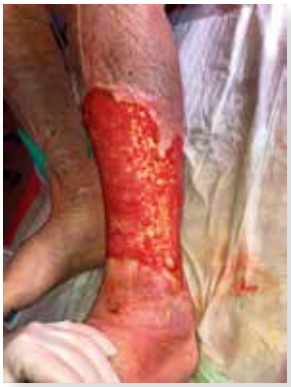


Fig. 4.7.5.2.2: 29/10/2020

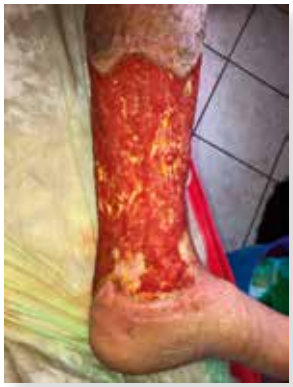


Fig. 4.7.5.2.3: 29/10/2020

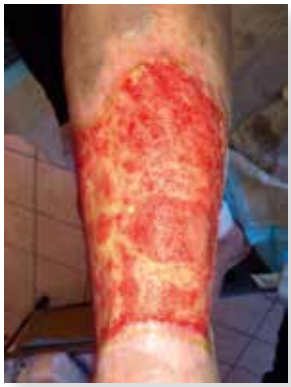


Fig. 4.7.5.2.4: 09/12/2020

On 09/12/2020 the wound treatment was changed to LIGASANO® white. After wound cleaning with Polyhexanid solution, the wound was covered with four peaces of LIGASANO® white, each in the size 24 x 16 x 1 cm. Compression bandages were further applied.
The wound shows a clear improvement regarding the wound coatings. Wound dressing change furthermore daily.

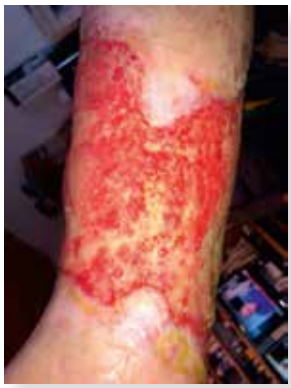


Fig. 4.7.5.2.5: 09/12/2020

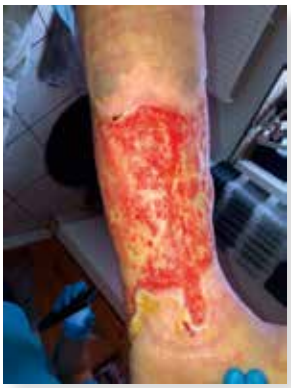


Fig. 4.7.5.2.6: 09/12/2020

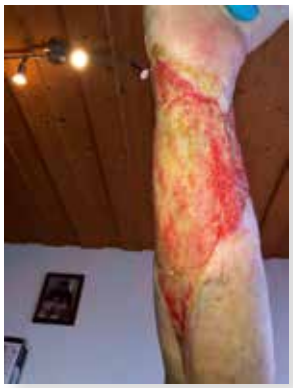


Fig. 4.7.5.2.7: 09/12/2020

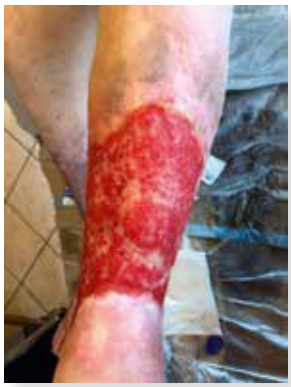


Fig. 4.7.5.2.8: 30/12/2020

The period from 30/12/2020 to 10/02/2021 continues to show good visible results.

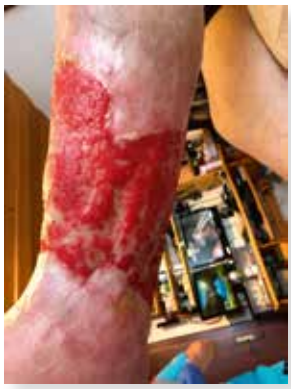


Fig. 4.7.5.2.9: 30/12/2020

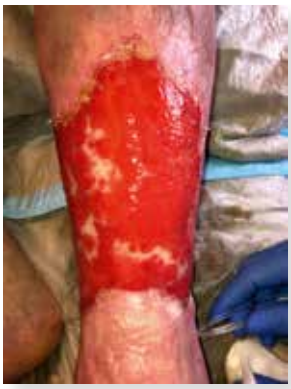


Fig. 4.7.5.2.10: 10/02/2021

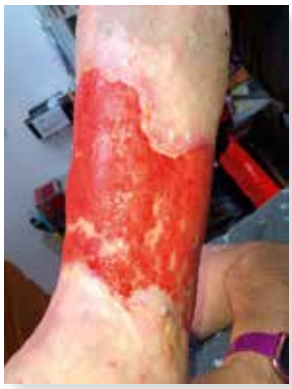


Fig. 4.7.5.2.11: 10/02/2021

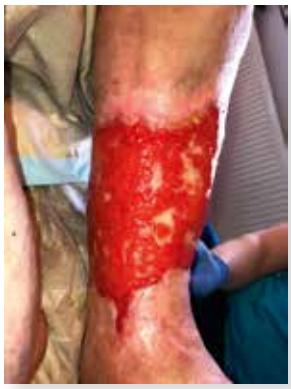


Fig. 4.7.5.2.12: 10/02/2021

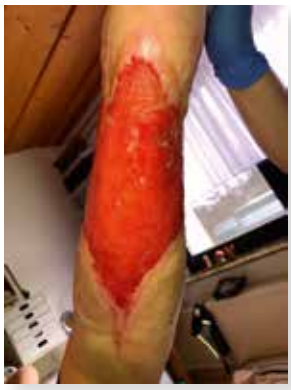


Fig. 4.7.5.2.13: 10/02/2021

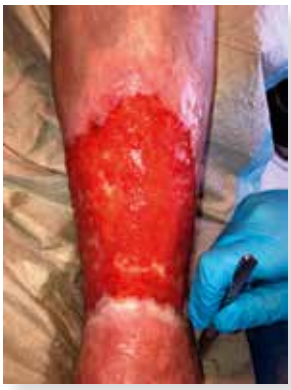


Fig. 4.7.5.2.14: 07/04/2021

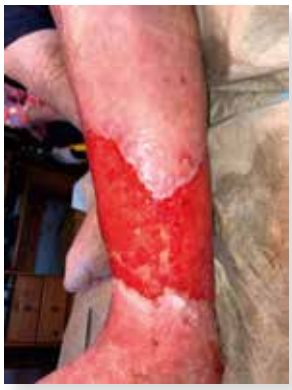


Fig. 4.7.5.2.15: 07/04/2021

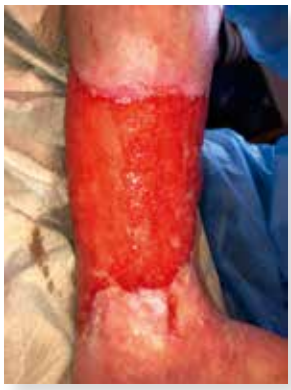


Fig. 4.7.5.2.16: 07/04/2021

On 07/04/2021, the wound continues to show a good healing tendency. The wound care continues to be carried out with LIGASANO® white 24 x 16 x 1 cm. The interval between dressing changes was extended to two days.

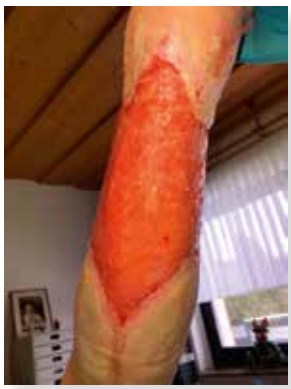


Fig. 4.7.5.2.17: 07/04/2021

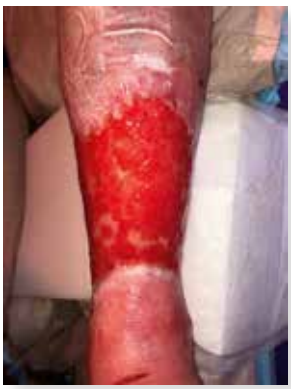


Fig. 4.7.5.2.18: 26/05/2021

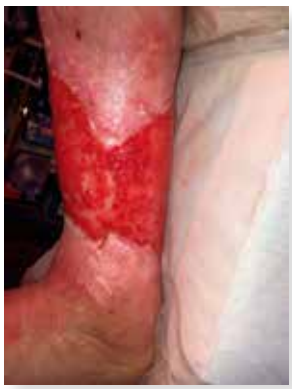


Fig. 4.7.5.2.19: 26/05/2021

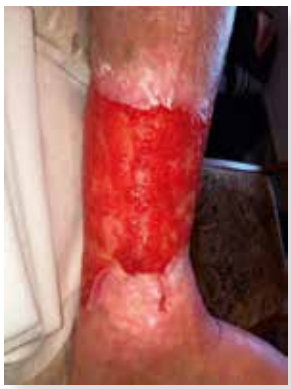


Fig. 4.7.5.2.20: 26/05/2021

Fig. 4.7.5.2.21: 26/05/2021

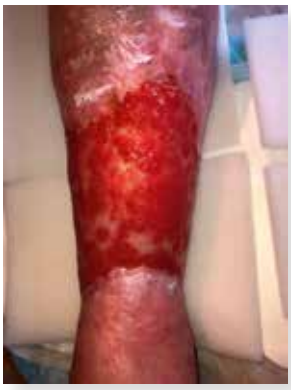


Fig. 4.7.5.2.22: 16/06/2021

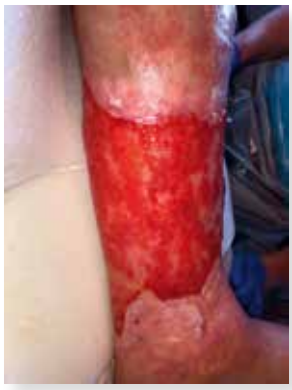


Fig. 4.7.5.2.23: 16/06/2021

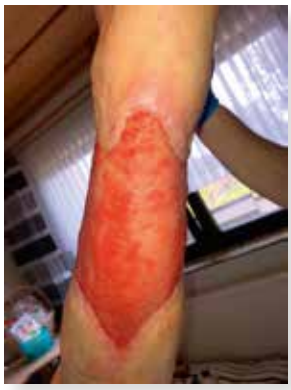


Fig. 4.7.5.2.24: 16/06/2021

On the pictures of 26/05/2021 and 16/06/2021, further progress is clearly visible. On the inner side, the wound has clearly reduced in size. The area directly above the inner ankle is epithelised.

Conclusion:

The coatings, which were present at the beginning of the therapy, have been dissolved quickly and effectively with LIGASANO® green. Due to the increasing granulation tissue, it was possible to switch to wound treatment with LIGASANO® white after only 10 days. During the following weeks, well perfused granulation tissue continued to form under the therapy with LIGASANO® white, which further developed into clearly visible epithelial tissue islands. The therapy with LIGASANO® white is continued because of the painless and easy dressing change and the good healing tendency, despite the probable autoimmune cause.

Treatment Example 3

The article „Negative pressure wound therapy with an alternative foam dressing" of Leonard Walle and Hisham Fansa was published in the Chirurgischen Allgemeinen Zeitung (CHAZ), vol. 14. issue 10 (2013) page 609-612:
According to the authors, the indication for negative pressure wound therapy is limited in wounds, which are loaded with detritus. Because the accumulation of flaky secretions, fibrin deposits and necroses would clog the pores of the foam. The authors report about a patient, in whom they used a special extra large pored polyurethane foam for NPWT after a stagnation of healing under standard negative pressure wound therapy:

Fig. 4.7.4.1: contaminated and coated abdominal wound with necroses before treatment with LIGASANO® green (intraoperative before debridement).

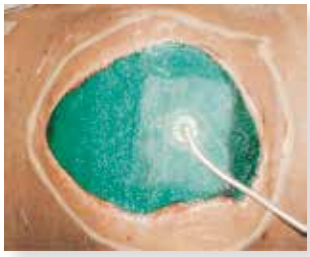


Fig. 4.7.4.2: negative-pressure-wound-therapy with LIGASANO® green.

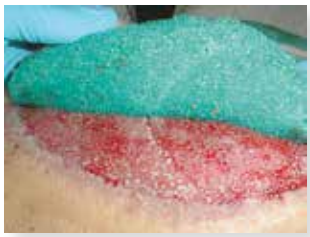


Fig. 4.7.4.3: Granulation tissue after 12 days of therapy with LIGASANO® green foam.

„A 43-year-old biker suffered an accident with polytrauma: diaphragmatic rupture of the left diaphragm, spleen and liver rupture, gall bladder tear, lung contusion and rib serial fractures. The treatment of the open abdomen was performed after splenectomy, cholecystectomy, hemostasis of the liver, and thoracotomy.
Intensive care treatment was necessary for four weeks. Besides nicotine abusus there were no other pre-existing diseases known. A secondary suture was not possible, thus we installed from the 10th day on after surgery the conventional V.A.C.® Abdominal Dressing System (pore size 400–600 µm) with a continuous suction of 100 mmHg.
After three weeks and six foam dressing changes including debridement no appreciable granulation tendency of the wound cavity. Additionally there was no absorption of secretion and detritus (fig. 4.7.4.1).
Thereupon we put the indication for the large-pored PU foam LIGASANO® green in place, that has a pore size up to 3.5 mm.
This foam is CE marked (class IIb) and has been used in wound care for over 30 years. An application in combination with electrical devices (e.g. NPWT device) has not been checked by the manufacturer. This procedure was discussed in detail with the patient's supervisor and an individual therapy attempt was arranged.
After debridement of the new necroses we installed the NPWT with a continuous suction of 100 mmHg. Already after one therapy a thin granulation tissue evolves.
All in all we made two dressing changes in an interval of 3-4 days (fig. 4.7.4.2 + 4.7.4.3). Coatings and flaky secretion were drained adequately, without obstruction of the foam or the drain system. When there was enough granulation tissue, we made a split skin graft covering (1:1.5 mesh).
After nine month we closed the obligatory hernia electively in an interdisciplinary procedure through mesh implantation and abdominal plastic (fig. 4.7.4.4 + 4.7.4.5)."

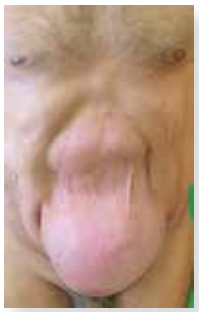


Fig. 4.7.4.4: nine months later: completely healed skin transplant and hernia.

Fig. 4.7.4.5a+b: six months after abdominal plastic.

Chapter 5: Prevention with LIGASANO® white and LIGASANO® green

5.1 Preface, Facts, Data

According to deliberate estimations, in Germany annually more than 400000 persons develop a pressure ulcer in need of therapy. Trusted data for the incidence are available only rudimentary, in particular for the domestic sector. In agreement with the actual issue of "Expert Standard Decubitus Prophylaxis in Care", the decubitus prevalences in hospitals range between 18 and 24%, and in long-term care facilities about 30%.

Indeed, the prevalences of pressure ulcer are significantly less, as shown by the Charité study. All in all 31,596 inhabitants of 396 nursing homes and 55,511 patients of 283 hospitals participate in the prevalence measurement from the years 2001 to 2011. The average age was 76.2 years in nursing homes and 53.1 years in hospitals, the body mass index was 24.9 (nursing homes) resp. 26.9 (hospitals). The percentage amount of women in nursing homes (76.2%) was considerably above their amount in hospitals (53.1%). **It is also striking that decubitus prevalence has steadily declined over the years**, which may possibly be caused by the implementation of the expert standard decubitus prophylaxis. All in all the decubitus prevalence is higher in hospitals than in nursing homes. Further the study developed that patients/inhabitants with a low Braden index (≤ 20) have more often and also deeper decubital ulcerations.

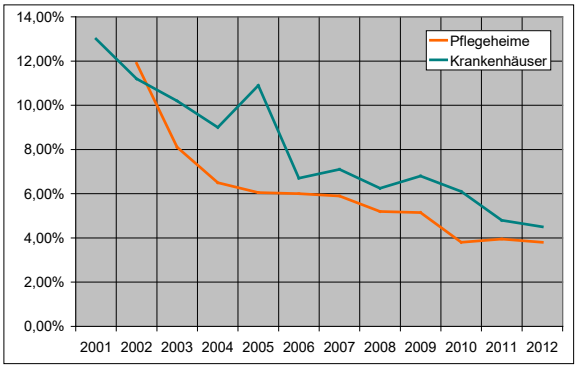


Fig. 5.1.1: graphic adapted from the presentation „Wer machts besser? - Pflege in Krankenhäusern und Pflegeheimen: Probleme mit Dekubitus", slide 19, of Dr. rer. cur. Nils Lahmann http://deutschespflegeforum.de/fileadmin/redakteure/pdf/Lahmann_Berlin_DPF_11_06__2014.pdf

In 2000, the German Network for Quality Development in Care (DNQP) has published the **Expert Standard Decubitus Prophylaxis in Care** for the first time. Since June 2017 a second edition is available. General objective is the prevention of pressure ulcers. In view of the present knowledge regarding the possibilities of prevention of pressure ulcers, the reduction to minimum has to be aimed. It is of outstanding meaning, that the nursing staff provides for systematic risk assessment, instruction of patient respectively persons concerned, exercise support, pressure reduction and continuity of prophylactic measures.

Pressure sores are a great strain for the persons concerned, the treatment is expensive and complex, and the healing is very protracted. Hence, it must be the topmost concern to prevent decubital ulcers; from medical, nursing, ethic and health economical point of view. Namely by means of effective and cooperative provided preventive measures.

A systematic review of the epidemiology of pressure ulcers in Germany published in 2019 by Tsenka Tomova-Simitchieva et al (Gesundheitswesen 2019; 81(06): 505-512; DOI: 10.1055/s-0043-122069) concluded that pressure ulcers were a common phenomenon in all healthcare settings in Germany.

As is generally recognized, the incidence and prevalence of pressure ulcers represent quality of care.Pressure ulcers are classified into six categories according to EPUAP (see page 50 in our compendium). Often, the diagnosis of a category 1 pressure ulcer is inaccurate or uncertain, which is why EPUAP recommends that pressure ulcer frequencies always be inclusive and exclusive of category 1.

Table 5.1.2 shows pressure ulcer prevalences in German hospitals.

	AQUA, IQTIG (as of 2015)	Hospital Statistics (ICD-10 Main Diagnosis)	DRG Statistics (ICD-10 Secondary Diagnosis)	Charité (Lahmann et al.)
2010	4.37	0.07	2.32	7.12
2011	4.09	0.07	2.33	4.82
2012	3.84	0.07	2.16	4.48
2013	1.59 (as of cat. 2)	0.07	2.26	2.11
2014	1.55 (as of cat. 2)	0.07	2.13	3.88
2015	1.57 (as of cat. 2)	0.07	2.18	5.21

Fig. 5.1.2: Table from Tomova-Simitchieva et al (2019) shows prevalences for pressure ulcer in German hospitals; abbrevations: **AQUA** = Institute for Applied Quality Promotion and Healthcare Research; **IQTIG** = Institute for Quality Assurance and Transparency in Healthcare; **ICD** = International Statistical Classification of Diseases and Related Health Problems; **DRG** = Diagnosis related groups; **Charite** = 6 different publications: (1) Lahmann N, Kottner, J. Nursing problems in Germany. Results of 10 years of research in nursing homes and hospitals., in Dassen T, (Ed.), Berlin 2010: 7-39; (2) Lahmann N, Wilborn D, Lützkendorf D, Nursing problems in Germany. Results in nursing homes and hospitals 2001-2011, in Dassen T, (Ed.), Berlin 2011: 7-36; (3) Lahmann N, Kottner J, Raeder K. Nursing problems in Germany. Results of 12 years of research in nursing homes and hospitals. 2001-2012, in Dassen T, (Ed.) Berlin 2012: 9-41; (4) Lahmann N, Kottner J, Kühnast P et al. Nursing problems in Germany. Results of 13 years of research in nursing homes and hospitals. 2001-2013. In Dassen T (Ed.), Berlin 2013: 9-37; (5) Lahmann N, Kottner J, Kuntz S et al. Nursing problems in Germany. Results of 14 years of research in nursing homes and hospitals. 2001-2014, in Dassen T (Ed.), Berlin 2014: 5-30; (6) Lahmann N, Kottner J, Kuntz S et al. Nursing problems in Germany. Results of 15 years of research in nursing homes and clinics.. In Dassen T (Ed.), Berlin 2015: 7-33

Table 5.1.3 shows pressure ulcer prevalences in German nursing homes.

	Charite (Lahmann et al)	MDS	ZQP (Schaeffer et al)	Kottner et al	Klingenhöfer-Noe et al	Wingen-feld et al	Ruscher et al
2010	4.29	4.38		3.91	3.90	4.38	
2011	3.91		6.48				
2012	3.60						
2013	6.74	3.77					3.40
2014	2.66					7.90	
2015	3.62						

Fig. 5.1.3: Table from Tomova-Simitchieva et al (2019) shows the prevalences of pressure ulcer in German nursing homes. Abbrevations: **Charite** = 6 different publications, see text Fig. 5.1.2; **MDS** = Medical Service of the National Associations of Health Insurers. Care/quality reports ; **ZQP** = Center for Quality in Care. Final Report Quality and Health in Inpatient Care for the Elderly., Bielefeld 2012; **Kottner et al** = Kottner J, Dassen T, Lahmann N et al. Dekubitus in deutschen Pflegeheimen: Häufigkeiten, Grade und Entstehungsorte. Zeitschrift für Gerontologie und Geriatrie 2011,44: 318-322; **Klingelhöfer-Noe et al** = Klingelhöfer-Noe J, Dassen T, Lahmann N. Nursing homes versus assisted living facilities. Zeitschrift für Gerontologie und Geriatrie 2015, 48: 263-269; **Wingenfeld et al** = 2 Veröffentlichungen: (1) Wingenfeld K, Engels D et al. Entwicklung und Erprobung von Instrumenten zur Beurteilung der Ergebnisqualität in der stationären Altenhilfe, Abschlussbericht 2011; (2) Wingenfeld K. Qualitätsunterschiede sichtbar machen. Die Schwester Der Pfleger 2015, 54: 82-85; **Ruscher et al** = Ruscher C, Kraus-Haas M, Nassauer A et al. Healthcare-associated infections and antimicrobial use in long term care facilities. Bundesgesundheitsblatt 2015, 58: 436-451

Table 5.1.4 shows pressure ulcer prevalences in German outpatient care.

	MDS	ZQP (Schaeffer et al)	Klingenhöfer-Noe et al	Neumann et al
2010	3.74		2.27	
2011				
2012		3.98		
2013	3.16			
2014				2.88

Fig. 5.1.4: Table from Tomova-Simitchieva et al (2019) shows the prevalences of pressure ulcer in German nursing homes. Abbrevations: **MDS** = Medical Service of the National Associations of Health Insurers. Care/quality reports; **ZQP** = Center for Quality in Nursing; Nursing-related health problems in outpatient care and supply in the Federal Republic of Germany 2015, Final report; **Klingelhöfer-Noe et al** = Klingelhöfer-Noe J, Dassen T, Lahmann N. Nursing homes versus assisted living facilities. Zeitschrift für Gerontologie und Geriatrie 2015, 48: 263-269; **Neumann et al** = Neumann N, Mischler D, Cuny C et al. Multidrug-resistant organisms (MDRO) in patients in outpatient care in the Rhine-Main region, Germany in 2014, in Bundesgesundheitsblatt 2016, 59: 292-300

Notwithstanding all methodological limitations and lack of comparability, according to the review by Tomova-Simitchieva et al, the prevalence in long-term care is 2% to 5%. Due to the very heterogeneous data situation, this estimation is hardly possible for German hospital patients, but a prevalence of 2% and higher can be assumed. These proportions would prove that available decubitus prophylactic measures in Germany would not be exhausted. Further efforts would have to be made to improve pressure ulcer prevention in Germany. Once developed, pressure ulcers are very stressful for those affected, their treatment is expensive and complex, and healing takes a very long time. Therefore, from a medical, nursing, ethical, and health economic perspective, the primary concern must be to prevent pressure ulcers. And it does so through successful, cooperatively delivered preventive measures.

According to the authors of the expert standard "decubitus prophylaxis", it is the result of a complexe inter-action between many structures and processes within an organisation, whether a decubitus develops or not. Prevention of pressure sores is therefore always a management task. The incidence of pressure ulcers correlates with the care quality of a facility or care service. At the same time, the expert standard admits that in practice not all pressure ulcers are generally avoidable. The factors **pressure duration**, **pressure intensity** and **tissue tolerance** are key factors in the development of decubital ulcers. Both compressing forces (affecting the tissue vertically) and shearing forces (affecting the tissue vertically and tangentially) are responsible for the formation of pressure sores. But duration and intensity of pressure are the decisive factors. Depending on the tissue tolerance, a decubital ulcer may occur within a short time. The capillary vessels are compressed by the pressure, therefore it comes to an insufficient supply of the affected areas with oxygen and nutrients. Also metabolites cannot taken away. If this situation consists, the cells die and a necrosis develops.

But not all wounds, which look like a decubital ulcer, are really one. In many cases this is a maceration of the epidermis and partly the dermis, caused by moisture and friction. In practice, it is not easy to distinguish the both. The following table may help you:

	Pressure ulcer	Maceration caused lesion
Localisation	developes over bones (e.g. sacral bone)	develops in a skin fold (e.g. on the tail bone)
Wound environment	clearly demarcated	diffuse extend
Wound base	poor blood supply, possibly with necrosis	good blood supply, wound is not deeper than dermis

Table 5.1.5: comparison of decubital ulcer and maceration caused lesion

Finger test according to Phillips (see also page 51): Press a finger on the erythema. If a white outline occurs and the fingerprint looks **white for a short moment** after release, it is a reddenish, which you can push away. Thus the finger test is negative. This is **no pressure ulcer**, but an allergy or inflammation caused erythema.

If the **rednes cannot pushed away** and persists after release, the fingertest is positive: this is a **pressure-induced skin damage**.

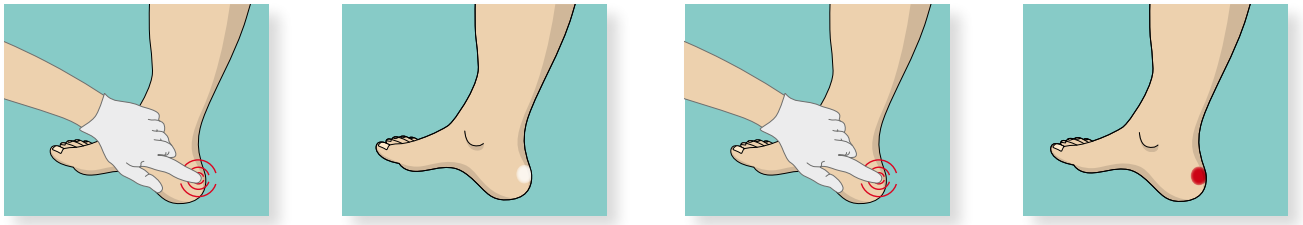


Fig. 5.1.3 to 5.1.6: finger test according to Jenny Phillips

5.2 Expert Standard "Decubitus Prophylaxis in Care"

Objective: Every patient/inhabitant gets a profylaxis, that prevents the development of decubital ulcer.

Structural criteria	Process criteria	Results criteria
S1 - **The qualified nurse** has actual knowledge about the genesis of pressure sores as well as competence to calculate the risk of decubital ulcers.	**P1** - **The qualified nurse** evaluates the decubital risk of all patients/inhabitants, directly at the beginning of the nursing process. This evaluation includes an initial screening as well as a differenciated assessment of the decubitus risk, if a risk was not excluded during screening. **The qualified nurse** repeats the evaluation in individual defined intervals and immediately, if mobility or activity changes or if extern factors (e.g. tubes, catheders), which may lead to higher and/or longer exposure of pressure and/or shearing forces.	**R1** An actual systematic evaluation of the individual decubitus risk is existent.
S2a - **The qualified nurse** has planning and control competence for decubitus profylaxis. **S2b** - **The institution** has a rule of procedure for the profylaxis of pressure sores.	**P2** - **The qualified nurse** plans individually together with the patient/inhabitant, that is in danger of pressure sores, and if applicable with his relatives, measures for decubitus profylaxis. The qualified nurse informs all involved participants about the decubitus risk and the need for uninterrupted continuation of the interventions.	**R2** The risk of decubital ulcer and the needed measures are known to all people, which are involved in the patient´s / inhabitants treatment and are continued without interruption.
S3a - **The qualified nurse** has the ability for information, training and guidance of patients/inhabitants and their relatives for the promotion of exercises, for skin observation, pressure relief measures and for the handling with pressure distributing aids.	**P3** - **The qualified nurse** explains the patient/inhabitant and (if applicable) his/her relatives the risk of pressure ulcer and the realisation of prophylactic measures and its evaluation.	**R3** The patient/inhabitant and his/her family know the reasons of the decubital risk as well as the planned measures and take part in its implementation, based on their possibilities.
S4 - **The qualified nurse** has knowledge of measures, which reduce pressure and promote the patient´s own movements. The qualified nurse knows and masters movement, positioning and transfer techniques, which are skin- and tissue-friendly.	**P4** - **The qualified nurse** promotes the patient´s own movements, as far as possible. If own movements are not or not sufficiently possible, the qualified nurse ensures immediately pressure relief by skin- and tissue-friendly movements of the patient/inhabitant and a completely pressure relief (free-positioning) of body sites at risk.	**R4** The patient´s/inhabitant´s own movement has been promoted and body sites at risk are relieved.
S5a - **The qualified nurse** has the competence, to judge the necessitiy and suitability of pressure distributing and pressure relieving aids and to apply it purposefully. **S5b** - **The institution** ensures that alternate pressure systems and soft positioning systems, according to the patient´s/inhabitant´s risk, are immediately available.	**P5** - **The qualified nurse** uses suitable pressure distributing and pressure relieving aids, additionally to pressure relieving measures, if the condition of the patient/inhabitant does not allow a sufficient promotion of his/her physical activity.	**R5** The patient/inhabitant gets a suitable pressure distributing and pressure relieving aid immediately.
S6a - **The qualified nurse** has the competence, to determine the efficiancy of the prophylactic measures. **S6b** - **The institution** provides ressources for recording pressure sores as well as for the evaluation of the pressure sore prophylaxis.	**P6** - **The qualified nurse** examines the skin condition of the patient/inhabitant at risk in individually intervals.	**R6a** The patient/inhabitant has no decubital ulcer. **R6b** The institution has data of pressure sore incidence and for the effectiveness of pressure sore prophylaxis.

Table 5.2.1: translated from Deutsches Netzwerk für Qualitätsentwicklung in der Pflege (Hrsg.): Expertenstandard Dekubitusprophylaxe, Zusammenfassung der Standardkriterien, 2. Aktualisierung 2017

Risk assessment / Risk Scales for calculation of pressure sore risk:
According to the expert standard "decubital ulcer prophylaxis in nursing" there are 100 risk factors for the development of a pressure sore. The presence of a risk factor would increase the possibility of the development of pressure sores. The guidelines, which are used by the experts working group (AWMA 2012, KCE 2012, Children´s Hospital 2012, Spinal Cord Medicine 2014, NICE 2014, NPUAP/EPUAP/PPPIA 2014) have named in most cases the following risk factors:

- Poor nutrition state
- Reduced activity and mobility
- Increased skin moisture
- Concommitant diseases (e.g. diabetes mellitus)
- Reduced sensoric sensing
- Demographic variables (e.g. age, sex or ethnic affiliation)
- Perfusion and support with oxygen of the skin
- Already existing decubital ulcer

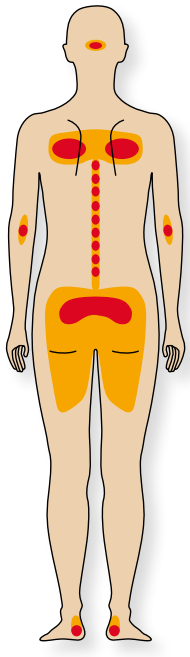
Additionally, expert standard "decubital ulcer prophylaxis in nursing" says, that comparative studies to the causality of decubitus development suggest that immobility, skin condition/decubitus and poor perfusion have a direct causal correlation to the development of a pressure sore. Further risk factors, such as urinary and faecal incontinence, skin temperature, underweight, old age and diabetes mellitus, would increase the risk of decubital ulcers, in combination with the causal direct effecting factors. The expert standard advices, that the risk assessment should include the following aspects: evaluation of the medical history, risk evaluation with scales, assessment of skin condition, assessment of mobility and activity, determination of the nutritional state, continence grading, cognitive grading, assessment of extrinsic risk factors. The use of risk scales may thereby effect supporting. The scales, which are named most frequent in the guidelines are Braden scale, Norton scale, Waterlow scale and Cubbin-Jackson scale.

Braden scale	1 point	2 points	3 points	4 points
Sensory perception Ability, to react adequately on pressure caused symptoms	**Completely missing** • no reaction on painful stimuli; possible reasons: - loss of consciousness, sedation *or* - Pain sensation disorder by paralysis, that affects the most part of the body	**Massive limited** • Reaction only on heavy pain stimuli • Hardly possible to utter the pains (only by e.g. moaning or unrest) *or* • Disturbation of pain sensibility by paralysis, that affects half of the body	**Slightly restricted** • Reaction on speech or command • Not always possible to utter discomfort (e.g. change of position) *or* • Disturbation of pain sensibility by paralysis, that affects one or two extremities	**Existing** • Reaction on speech, discomfort may be uttered *or* • No disturbation of pain sensivity
Activity Level of physical activity	**Bed-ridden** • confined to bed	**Sits up** • Is able to walk with help • May not bear the own weight by himself/herself alone • Needs help to sit up (bed, chair, wheel-chair)	**Walks little** • Walks alone during the day, but rare and only little distances • Needs help for longer distances • Spends most of the time in bed or on the chair	**Walks periodically** • Walks regularly 2-3 x per working shift • Moves regularly
Mobility Ability to change and hold the bodies position	**Completely immobil** • Can not make any minimal change in position without help	**Mobility severe limited** • Moves sometimes little (body, extremities) • Is not able to change the position sufficiently alone	**Mobility little limited** • Makes regularly small position changes of the body and the extremities	**Mobile** • May change the position fully by himself/herself
Moisture Extend in which the skin is exposed to moisture	**Always moist** • The skin is always moist by urine, sweat or faeces • If the patient is positioned, he/she always lays wet	**Often moist** • The skin ist moist, but not always • Bed linnen or laundry needs to be changed one time in every working shift	**Sometimes moist** • The skin is sometimes moist, new laundry is needed once daily	**Seldom moist** • The skin is mostly dry • New laundry is needed only seldom
Nutrition Nutrition habits	**Very poor nutrition** • Eats up small portions never, only for approx. $^1/_3$ • Does not drink enough, eats no complementary food *or* • Only clear liquid • Obtains feeding infusion for longer than 5 days	**Moderate nutrition** • Eats up a normal portion only seldom, eats normaly half of the offered food • Takes complementary food unsteadily *or* • Gets not enough nutrients by tube feeding or feeding infusion	**Adequate nutrition** • Eats more than the half of a normal portion • Refuses a meal occasionally, but takes complementary food *or* • May intake the most nutrients by tube feeding or feeding infusion	**Well nutrition** • Eats always up the offered meals • Eats sometimes between the meals • Does not need complementary food
Friction and shearing forces	**Problem** • Needs many support in changing the position • Lifting is not possible without hauling over the bed sheet • Always slides down in bed or (wheel-)chair, needs to be lifted up again and again	**Potential problem** • Moves a little bit alone or needs less help • During lifting the skin hauls only little over the bed sheet (can lift his-/herself a little bit) • Can hold the position for a longer time (chair, wheel-chair) • Slips down only seldom	**No problem** • Moves alone in bed and chair • Has enough power to lift her-/himself • Can hold the position for a long time, without slipping down	
	Low risk	**Moderate risk**	**High risk**	**Very high risk**
	18-15 points	**14-12 points**	**11-9 points**	**< 9 points**

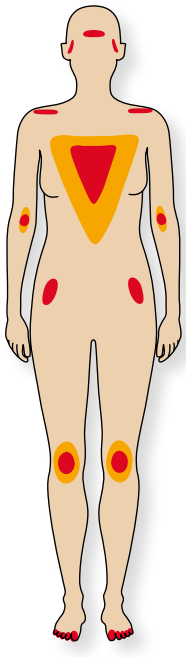
Table 5.2.2

5.3 Predilection Spots

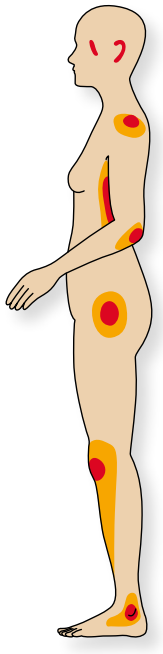
Predisposed spots for pressure ulcerations are all exposed bones with little soft tissue covering. These parts are especially charged in lying and sitting and need to be inspected carefully and regularly, in particular back of the head, ellbow, sacrum, pelvic bones, knee, ankles, heels.



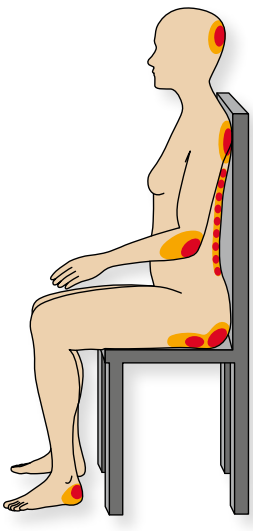
In **back position** are especially at risk: occiput bone, scapulae, spinous processes, sacrum, heels



In **prone position** are especially at risk: forehead, cheekbone, glenohumeral joints, sternum, ellbows, iliac spine, patella, tips of the feet



In **90° side position** are especially at risk: cheek bone, ear, glenohumeral joints, ribs, ellbows, great trochanter, knee joint, fibula, lateral ankles



In **sitting position** are especially at risk: back of the head, scapula, spinous processes, ellbows, ischial tuberosities, heels

5.4 Prevention and Concomitant Wound Treatment

The rapidly falling pressure tension of LIGASANO® white enables almost even distribution of pressure from the surface padding and thus avoids the dreaded pressure points.
All LIGASANO® products can simply be cut to fit. This is how aids such as pulleys, wedges and heel shoes, for example, are created for changing patients position, having been adapted by imaginative health care professionals.
The mechanical stimulus of LIGASANO® white promotes the peripheral blood supply where there is contact to skin, and the patients residual pressure increases. Surplus sweat is absorbed, leaving normal skin moisture, and care of the skin is also associated with the mechanical stimulus. The preservation of the physiological skin milieu is supported. If LIGASANO® white has the appropriate thickness it does not form any folds, thus actively preventing a further risk of pressure ulcer. Patients are always placed onto LIGASANO® white ensuring skin contact.

These properties will help you:

Mechanical stimulus

LIGASANO® white effects a mechanical stimulus, thus
- local promotion of perfusion
- improved supply with substances

Rapidly falling pressure tension

Properties of LIGASANO® white
- rapidly falling pressure tension
- pressure relief by pressure distribution

Controlled absorption effect, ventilation of the skin

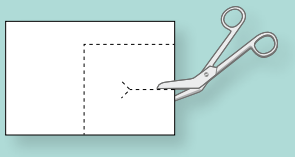
- LIGASANO® white absorbs
- LIGASANO® green ventilates

By this improvement of micro clima

Additional product advantages

Textiles form folds
LIGASANO® never

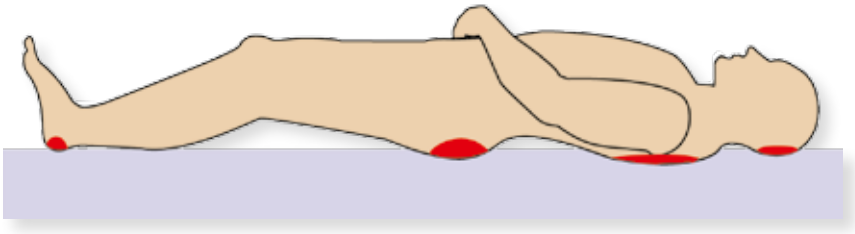
Additional product advantages



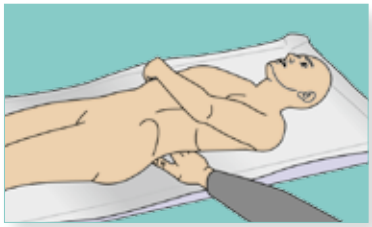
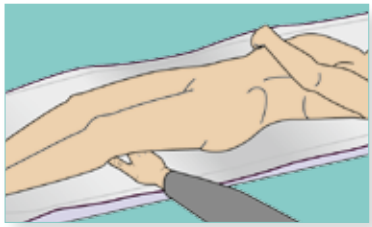
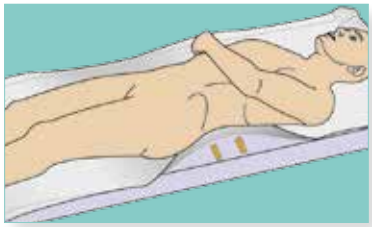
- LIGASANO® may be cut as required
- Adapts to the body contures

5.4.1 Pressure Relief by Pressure Distribution with LIGASANO® white and LIGASANO® green („anatomical bed"):

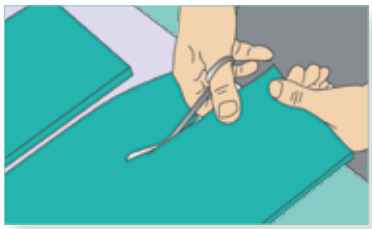
This decubitus prophylaxis can be arranged at nearly every bed. *Starting point:* the patient lies in bed, you will just make the bed anyway.

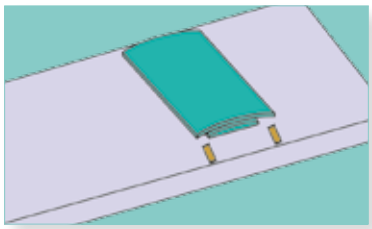


Feel, where the patient rests not or not fully.
This is always between the above showed pressure points.

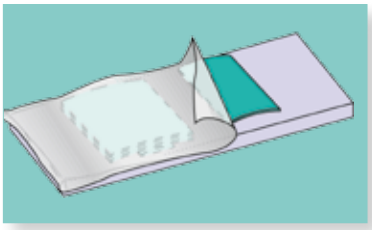
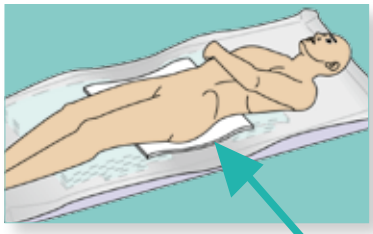




Fold the bed sheet back on the edge, so that you can apply plaster strips as marks directly on the mattress. Mark the positions on the mattress that you would like to underpad.



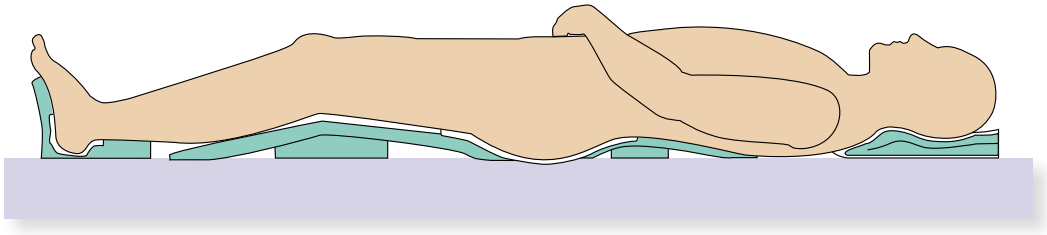


Cut fitting pads and place them on the marked positions.

Cover with the normal bed sheet and the patient may return to bed.

1 cm LIGASANO® white directly on the skin avoids folds, promotes blood flow and regulates skin moisture



You only need to do this positioning once; the pads always remain on the bed, directly on the mattress. Optimally you cover the mattress with the applied LIGASANO® green pads with an elastic bed sheet. This bed sheet and the pads are now an integral part of the mattress. The objective is, that the patient distributes his resting pressure evenly (= pressure relief by pressure distribution). Your flat hand under the patient´s body is a very sensitive measuring instrument.

The patient now will not slide from top to bottom or the other way around, because he feels comfortable as well as lying orthopaedically correct. When doing it the first time, you might have to touch it up a bit at the first and second day, but you will see how simple it is, once you have some experience. Time required: once about 10-15 minutes.

The above described positioning does not release you from changing your patients position in appropriate intervals and is normally suited without change for tilted and side positions, too.

Extraordinary bodily conditions (e. g. contractures) may also be balanced by the adaption of these paddings.

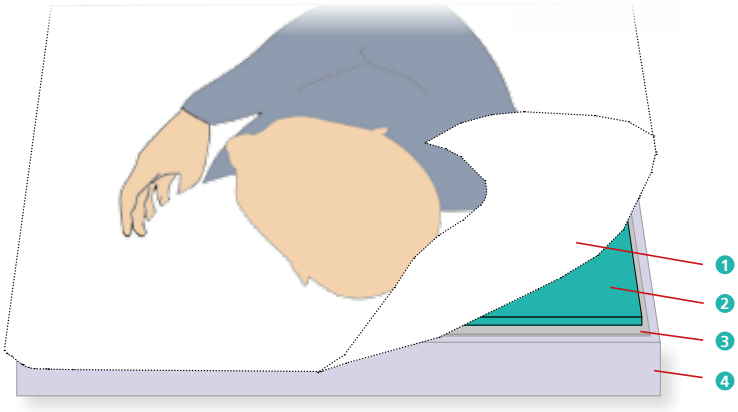
The „Anatomic Bed" cares for pressure relief by pressure distribution, as well as for an anatomically beneficial support of the backbone, which has a pleasant effect to well-being.

5.4.2. Individual Bed Pad

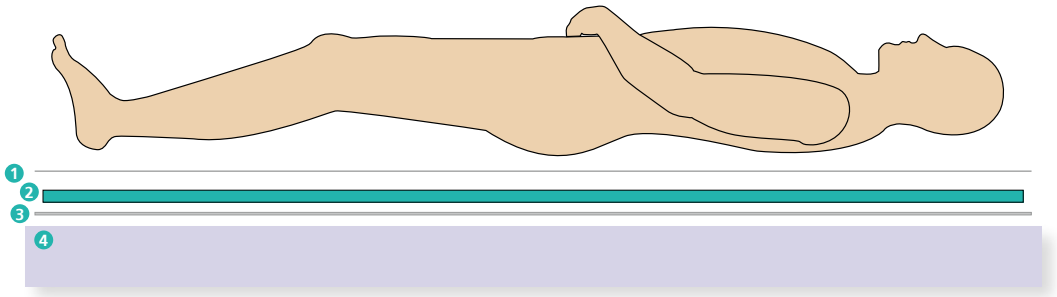
Please note: LIGASANO® green is rough. Therefore preferably avoid direct contact to skin for applications of this type! Use for example a bed sheet or LIGASANO® white between LIGASANO® green and the patient.

LIGASANO® green as a climate grid for

- heavy sweating patients
- allergy sufferers
- pain patients
- rheumatism patients
- palliative and appalic patients
- paraplegics

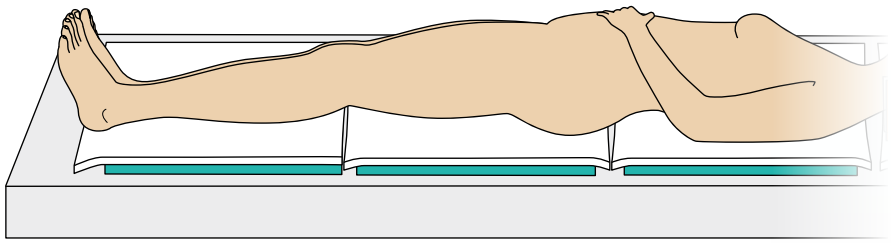


1. bed sheet
2. LIGASANO® green 190 x 90 x 2 cm
3. possibly absorbent pad
4. matress

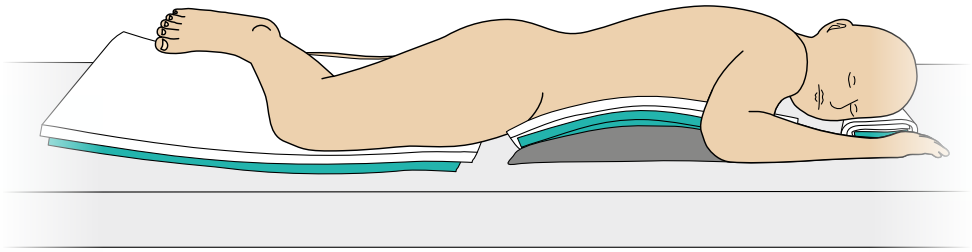


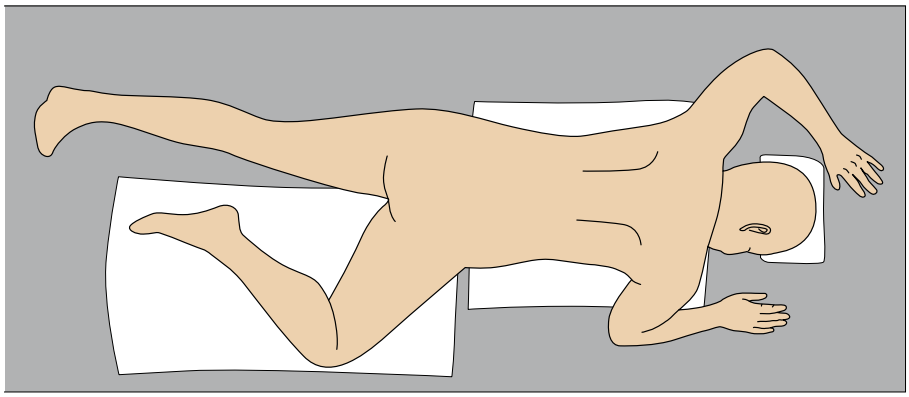
5.4.3 Positioning in Lying Position, Anatomically Adapted Pressure Relief

Practical example for back position with three sheets LIGASANO® green size 55 x 45 x 2 cm and three sheets LIGASANO® white size 59 x 49 x 2 cm

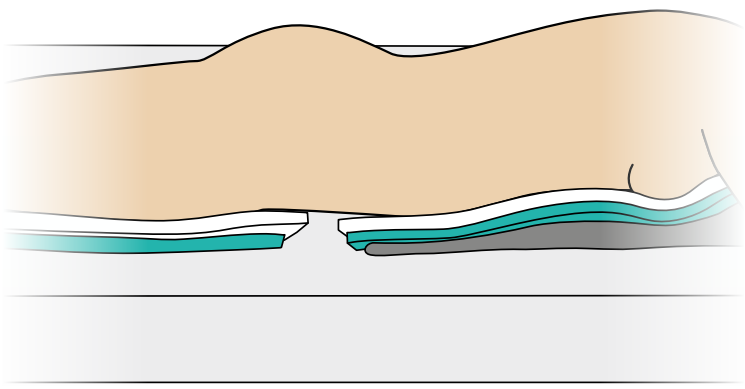


Practical example for 135° prone position with three sheets LIGASANO® green size 55 x 45 x 2 cm and three sheets LIGASANO® white size 59 x 49 x 2





Practical example for 180° prone position with two sheets LIGASANO® green size 55 x 45 x 2 cm and two sheets LIGASANO® white size 59 x 49 x 2 cm



Link to the video: positioning in 180° prone position

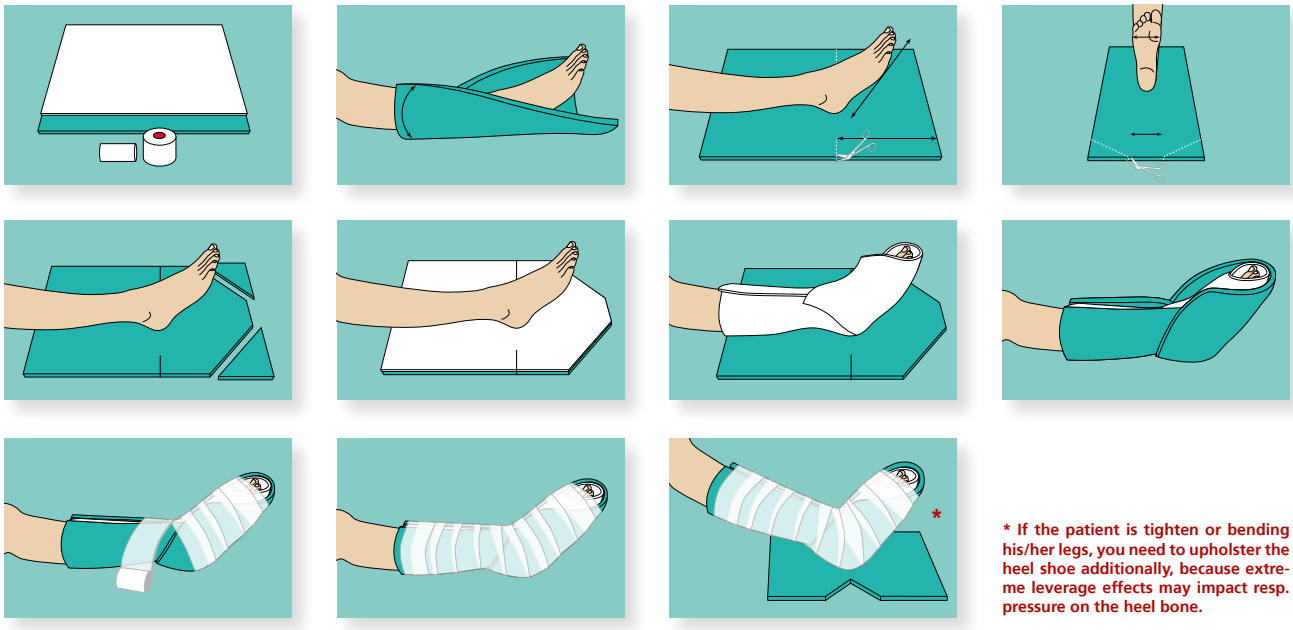
5.4.4 Individual Heel Shoes and Heel Guards

Individual heel shoe model 1

For manufacturing an individual heel shoe you need

- 1 sheet LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 2 cm
- 1 piece LIGASANO® bandage, 300 x 10 x 0.3 cm
- 1 piece fixation aid LIGAMED® *fix*

Link to the video: production of a custom-made heel guard

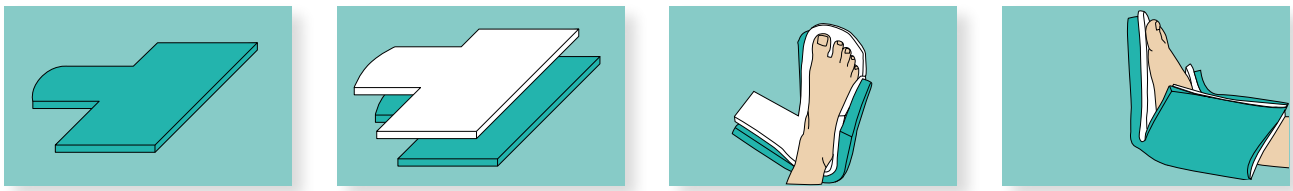


*** If the patient is tighten or bending his/her legs, you need to upholster the heel shoe additionally, because extreme leverage effects may impact resp. pressure on the heel bone.**

Individual heel shoe model 2

For manufacturing this heel shoe you need

- 1 sheet LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 2 cm
- 1 piece fixation aid LIGAMED® *fix*



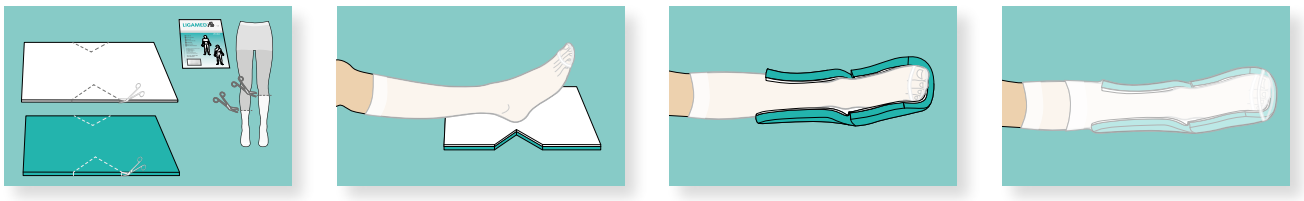
Heel cap model 1

For manufacturing this heel cap you need

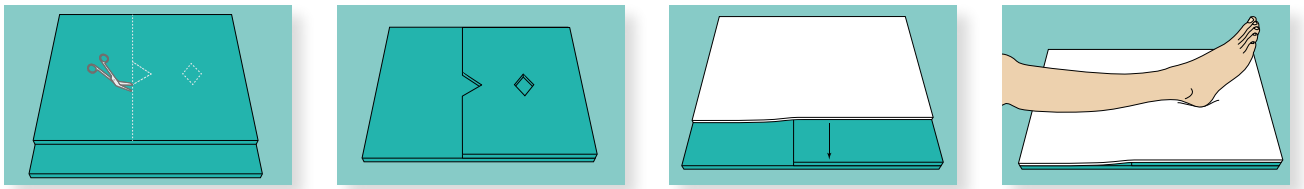
- 1 sheet LIGASANO® white, 24 x 16 x 1 or 2 cm
- 1 piece LIGASANO® bandage, 300 x 10 x 0.3 cm
- 1 piece fixation aid LIGAMED® *fix*

Link to the video: production of a custom-made heel cap

Heel cap model 2
For manufacturing this heel cap you need
- 1 sheet LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 1 or 2 cm
- 1 piece LIGASANO® bandage, 300 x 10 x 0.3 cm
- 1 piece fixation aid LIGAMED®*fix*



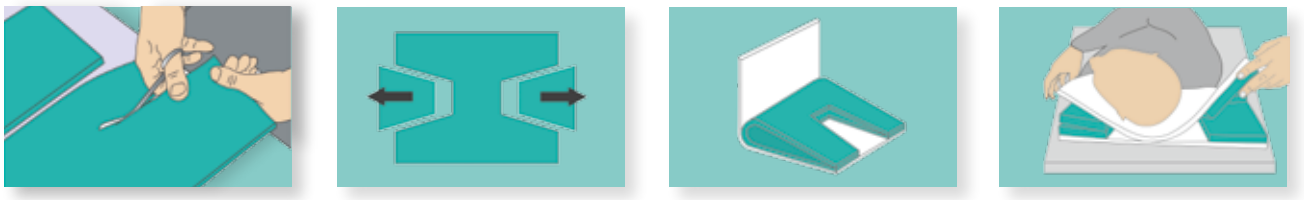
Pressure relief of the heel
To obtain a pressure distribution by anatomical adaption, you need
- 2 sheets LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 2 cm



Or as a ready made aid:
Both the original LIGAMED® heel shoe and LIGAMED® heel shoe plus protect the whole foot perfectly against pressure, decubitus, overheating and accumulation of moisture.
A detailed description please find on page 100.

5.4.5 Orthopaedic Pillow / Positioning of the Head

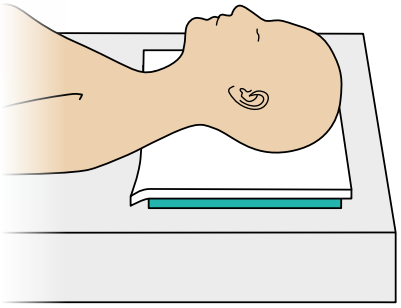
Within 5 minutes adapted individually + orthopaedically optimal. For manufacturing you need
- 1 sheet LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 2 cm



Positioning of the head **in back position** with LIGASANO® white and LIGASANO® green. For manufacturing you need

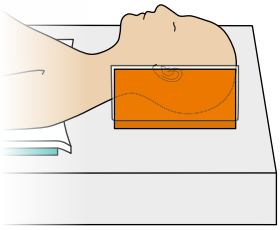
- 1 sheet LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 2 cm

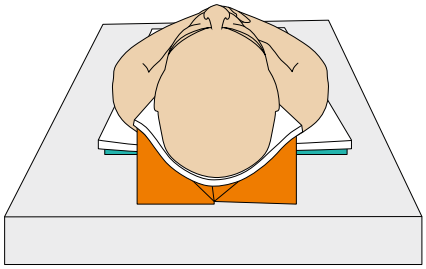
Link to the video: positioning of the head in supine position



Positioning of the head **in back position** with LIGASANO® white and LIGASANO® orange. For manufacturing you need

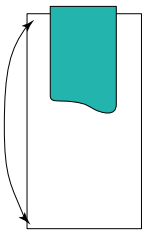
- 1 sheet LIGASANO® white, 59 x 49 x 2 cm
- 1 Positioning cube made of LIGASANO® orange, 24 x 12 x 12 cm

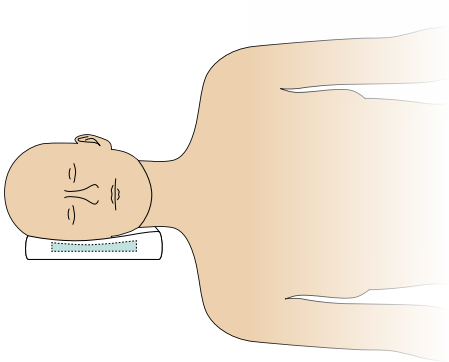




Positioning of the head **in lateral position** with LIGASANO® white and LIGASANO® green. For manufacturing you need

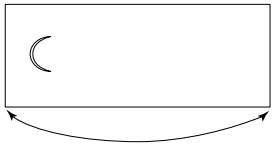
- 1 sheet LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 1 cm

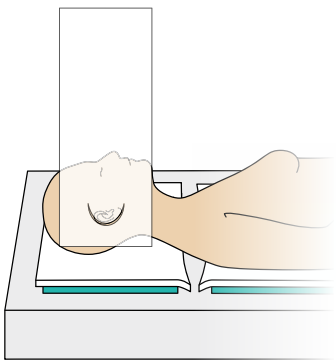




Pressure reduction of the ear with LIGASANO® white when the head is **in lateral position**. For manufacturing you need

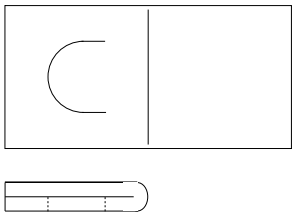
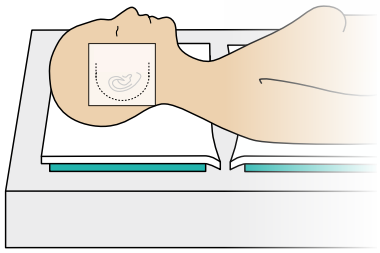
- 1 sheet LIGASANO® white, 59 x 49 x 1 cm: cut out, fold up 1-2x, fixation





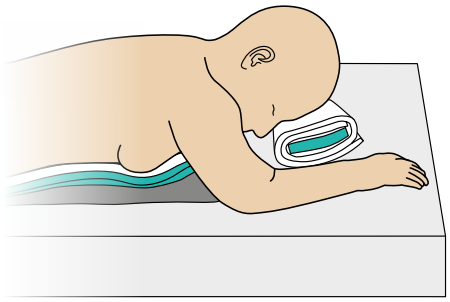
Link to the video: pressure relief on the ear

Pre-fabricated ear dressing made of unsterile LIGASANO® white. Use the ear dressing as a secondary dressing for existing decubitus on the ear and/or for prevention.
How to use the ear dressing made of LIGASANO® white: You only have to apply the ear dressing to the ear, fold it in and fixate it.

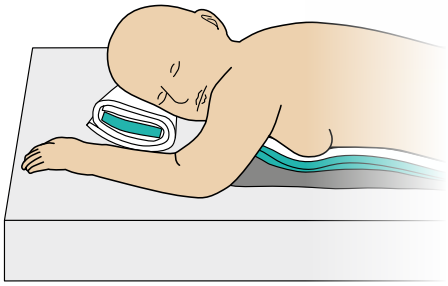




Positioning of the head in prone position with LIGASANO® white and LIGASANO® green. For manufacturing you need

- 1 sheet LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 1 cm



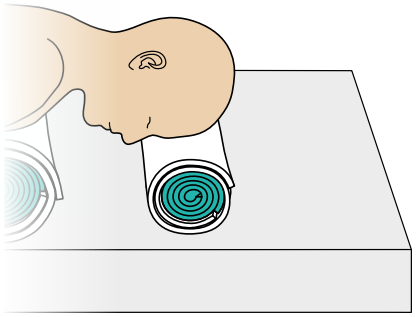
Link to the video: positioning of the head in prone position



Positioning of the head in prone position with a roll made of LIGASANO® white and LIGASANO® green. For manufacturing you need

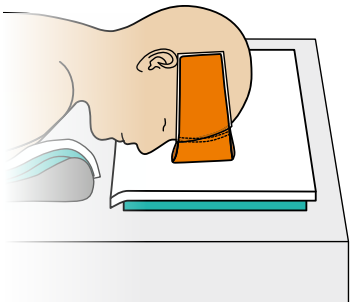
- 1 sheet LIGASANO® green, 200 x 60 x 1 cm
- 1 sheet LIGASANO® white, 200 x 60 x 1 cm

The roll has a diameter of approx. 22 cm.



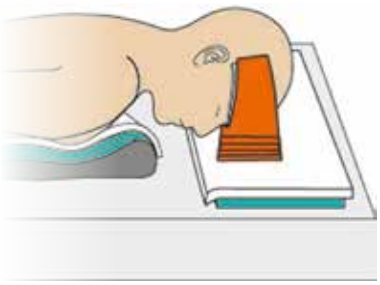
Positioning of the head in prone position with the Omega dressing pad made of LIGASANO® orange and skin contact pads made of LIGASANO® white. The height of the Omega pad is individually adaptable in 1cm steps. For manufacturing you need

- 1 OP LIGASANO® Omega pad + skin contact pad *plus if applicable*
- 1 sheet LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 1 cm



Positioning of the head in prone position with the Trapeze dressing pad made of LIGASANO® orange and skin contact pads made of LIGASANO® white. The height of the Trapeze pad is individually adaptable in 1cm steps. For manufacturing you need

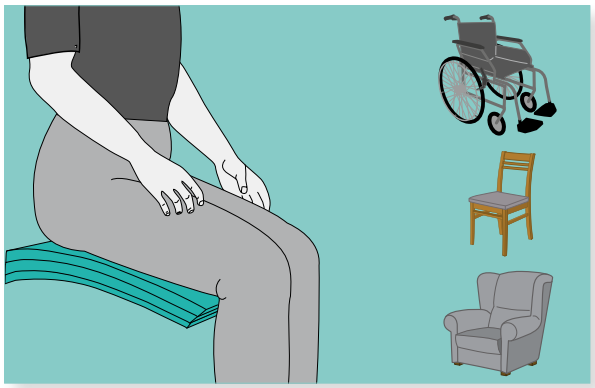
- 1 OP LIGASANO® Trapeze pad plus skin contact pad
  plus if applicable
- 1 sheet LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 1 cm



5.4.6 Sitting without Perspiration

For manufacturing an individual sitting cushion you need

- 1-3 sheets LIGASANO® green, 55 x 45 x 2 cm
- 1 sheet LIGASANO® white, 59 x 49 x 2 cm



In nursing homes, the seats of wheel-chairs, therapy chairs and also seating furniture are often covered with water repellent synthetics. This results in surplus moisture, when sitting on this chairs, especially in summer times. The skin becomes moist and thus more sensitive for intertrigo, fungal infections and inflammations.
An additional disadvantage of this water repellent coverings is their smooth surface. The inhabitants slide down while sitting on the chair or wheel-chair, and shearing forces affect especially on the sacral region, that has anyhow a risk for pressure sore.

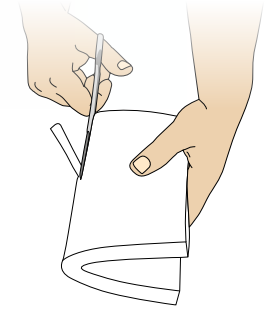
Our solution: put LIGASANO® green size 55x45x2 cm in several layers under the clothed buttocks on the seat! Because of its open-pored structure, LIGASANO® green provides a healthy micro climate in the seating area. Additionally it reduces pressure peaks and because of its surface structure, the patient can not slide in the seat. Except he wants this.

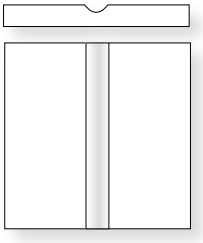
- No shearing forces, because the patient can not slip out
- No moist micro climate, which can cause intertrigo

For a normal patient with a weight of 70-80 kg, please take three sheets of LIGASANO® green size 55 x 45 x 2 cm and put it on the seat. Put the patient on the LIGASANO® padding and feel for the ischial tuberosities and other bone structures of the patient´s buttocks between seat and LIGASANO®. If you clearly feel bone structures, please put another sheet of LIGASANO® green on the seat, until you don´t feel a bone.

5.4.7 Padding of Catheters, Probes and Tubes:

LIGASANO® white for splinting and padding of catheters (e.g. jugularis catheter, Shaldon catheter), suprapubic catheter, permanent catheter, redon catheter, PEG and oxygen tubes.
For manufacturing you need 1 sheet LIGASANO® white size 59 x 49 x 2 cm **or** 24 x 16 x 2 cm

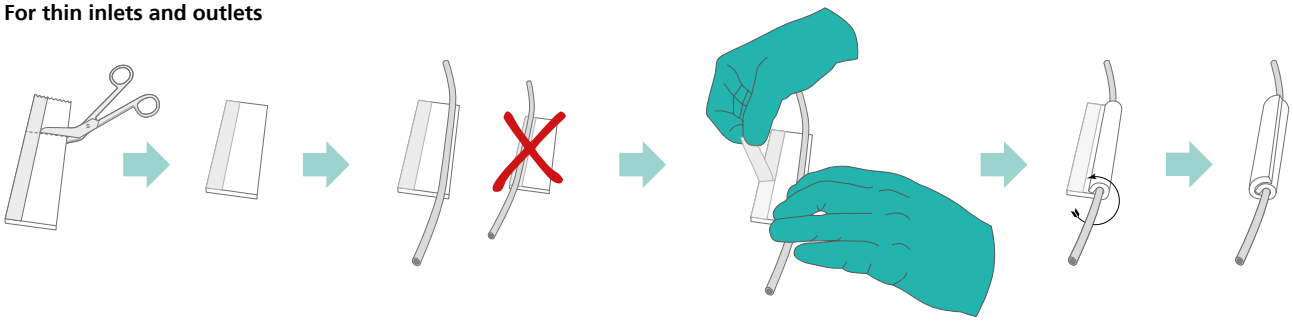




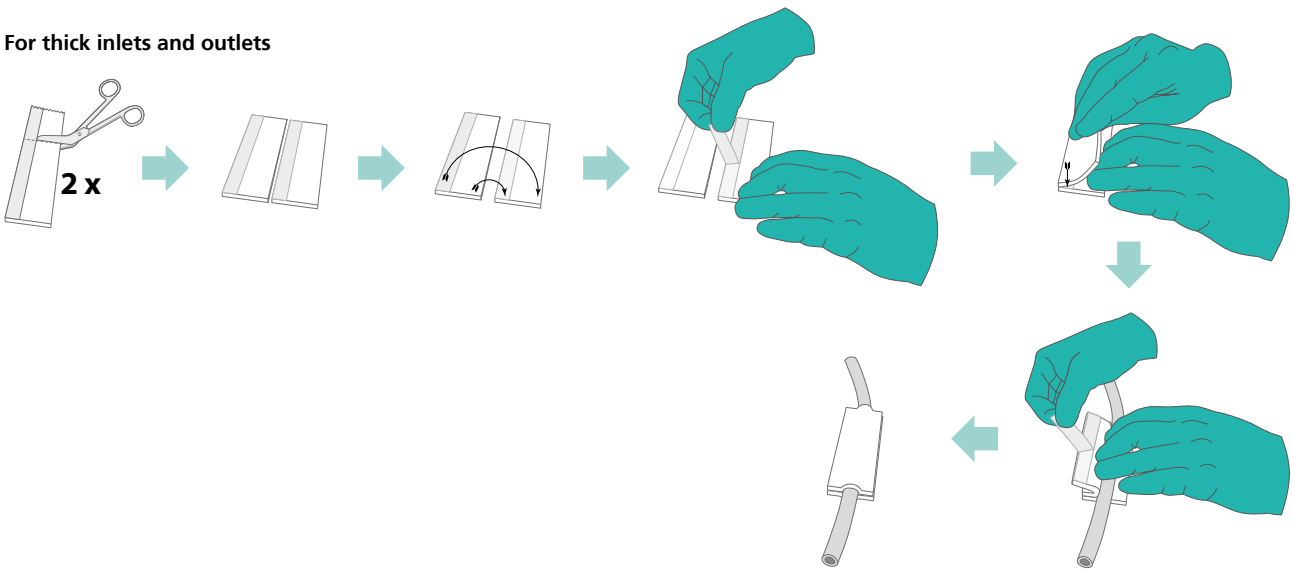
Link to the video:
Padding of supply
and discharge lines

Alternatively you can use LIGASANO® Roll with adhesive edge (roll in a dispenser box, length 200 cm, width 4.5 cm, thickness 0.4 cm. The width of 4.5 cm fits perfectly for the manufacturing of paddings for inlets and outlets on the body.

For thin inlets and outlets

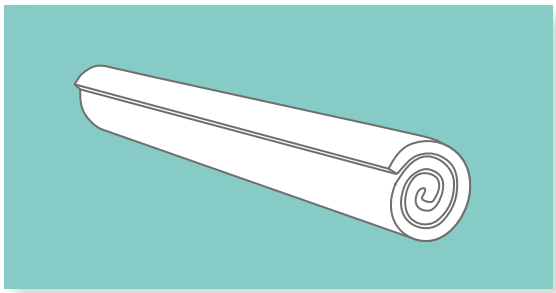


For thick inlets and outlets

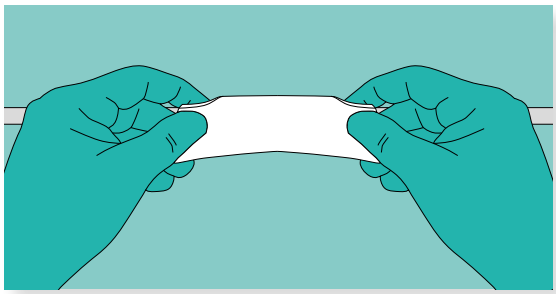


The **LIGASANO® spiral bandage** for padding supply and discharge lines on the patient, made of LIGASANO® white, was developed hand in hand with users and will save you time in patient care. The initial topic was the occurrence of pressure damage to the patient's tissue in the area of the inflow and outflow lines.

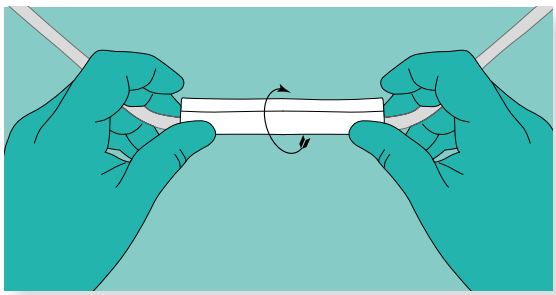
How to apply the LIGASANO® spiral dressing:



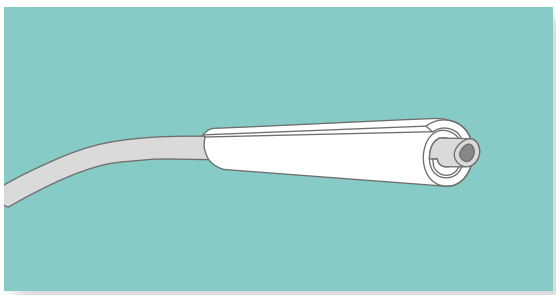
Remove the LIGASANO® spiral bandage from the packaging and cut it to the required length if necessary



Roll it up a bit so that you can put the supply or drain line in it

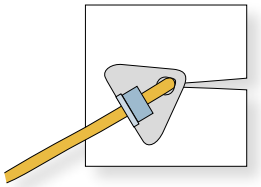


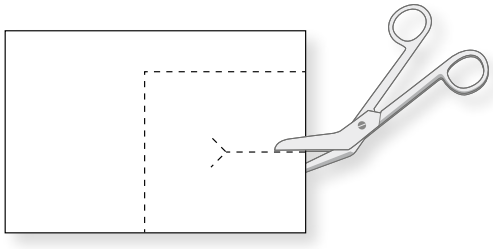
Place or roll the spiral bandage around the supply or drain line



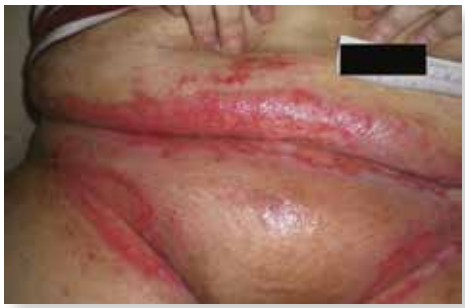
The patient is now protected against pressure points caused by supply or drain lines

Slit compresses made of LIGASANO® white are available each in sterile and unsterile quality in the sizes 5 x 5 x 1 cm, 7.5 x 7.5 x 1 cm and 10 x 10 x 1 cm. As an alternative you can cut the unsterile slit compress out of a LIGASANO® compress size 15 x 10 x 1 cm by yourself with a pair of scissors.





5.5 Intertrigo Prophylaxis, Intertrigo Therapy and Handling of Contractures

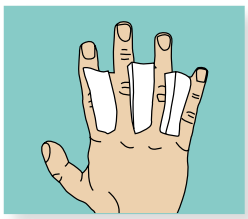


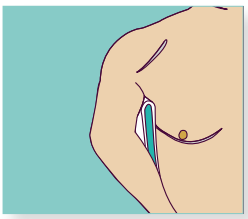
At bedridden patients and at immobilisation of articulations a contracture (ankylosis) and muscular atrophy (contraction of the muscles) may develop. Especially patients with phlogistic or degenerative arthropathy are at risk; but also patients with immobilised joints, e.g. by relieving posture, palsy or weakness. Measures for the maintenance of an intact musculoskeletal system are kinetotherapeutic exercises, mobilisation and adequate positioning. What is an intertrigo actually? Where direct contact from skin to skin exists, e.g. in skin folds or where for other reason no air comes to the skin, sweat can not evaporate and the skin macerates. In this moist-warm environment, bacteria and fungi may multiply excellently, finally the skin becomes sore and an intertrigo has developing.
Note: an intertrigo is often mistaked for pressure sore, especially in the buttocks area!
In the following we show you some suggestions for the prophylaxis of contractures and intertrigo:

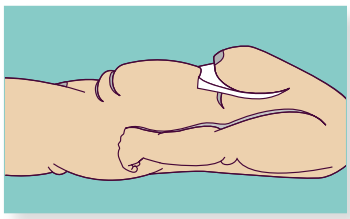
5.5.1 Prevention of Skin-to-Skin-Contact (Intertrigo Prophylaxis and Therapy)

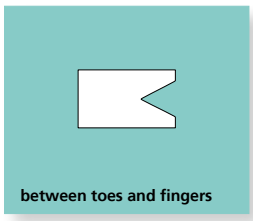
Not only for prevention but also as a concomitant therapy at mycosis treatment in connection with an antimycotic or a single therapy, if the skin is only irritated or inflamed. For manufacturing you need

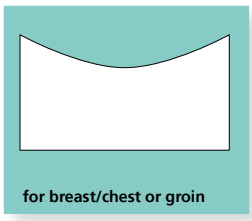
- 1 sheet LIGASANO® white 59 x 49 x 2 or 1 cm
  or
- 1 bandage made of LIGASANO® white 300 x 5 x 0.3 cm or 300 x 10 x 0.3 cm

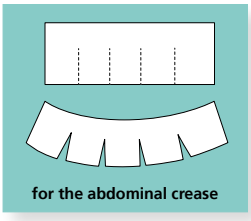




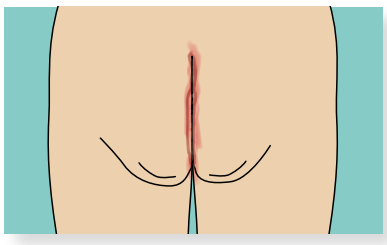


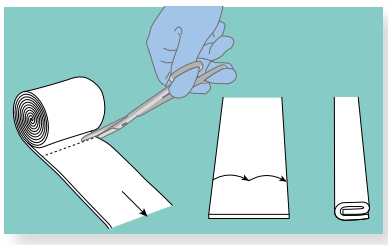


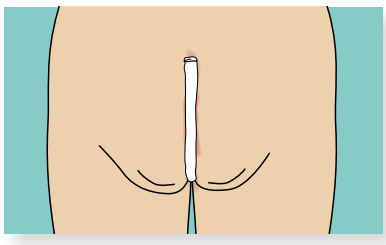


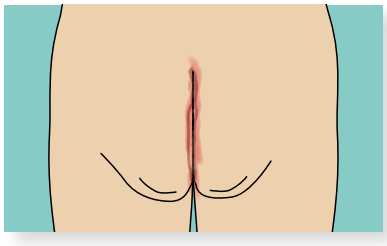


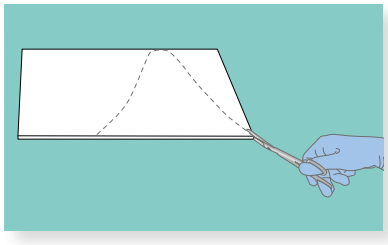
Link to the video:
prophylaxis of intertrigo

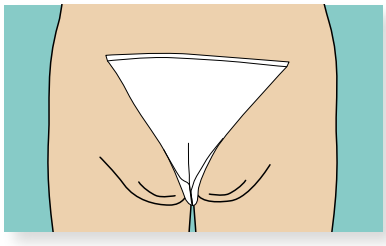










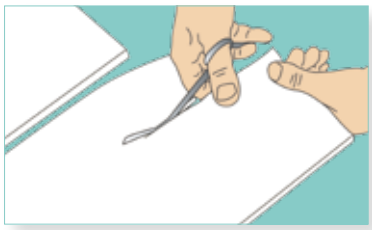
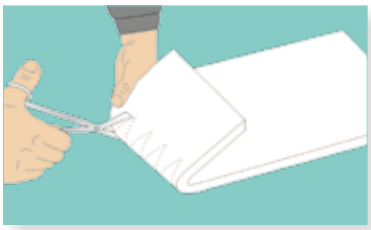
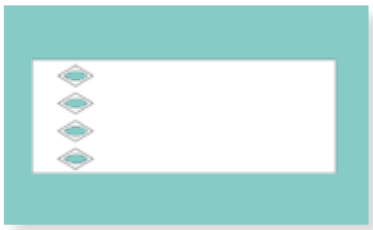


5.5.2 Positioning of the Hand / Palmar Dressing

Positioning of the hand in case of spasticity / for prophylaxis and therapy of contractures
Manufactured in one minute; prevents contractures and separates the fingers. Ideal in case of spasticity, because of the product´s rapidly falling pressure tension, no new spasticities will develop.
For manufacturing you need

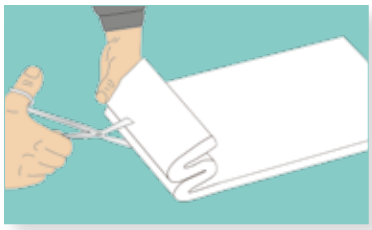
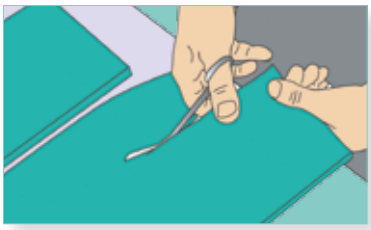
- 1 sheet LIGASANO® white 59 x 49 x 1 cm

Link to the video: positioning of the hand

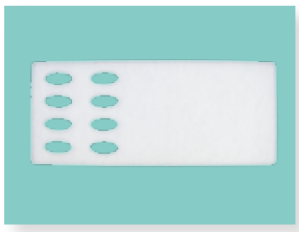
Finger separator / individual self-manufactured palmar dressing for atonic paralysis
For manufacturing you need

- 1 sheet LIGASANO® white 59 x 49 x 1 cm
- 1 sheet LIGASANO® green 55 x 45 x 2 cm


or pre-manufactured palmar dressing
For the application you need

- 1 original package LIGASANO® palmar dressing combined package or replacement package only with LIGASANO® white








Additionally you can cover the universal fixation aid LIGAMED® *fix* over it.
Note: **never use LIGASANO® green in case of spastic paralysis** in the palm, because this may lead to a strengthening of the spasticity.

6 Podiatry and Medical Foot Care

6.1 Introduction

What is podiatry anyway? It's "just" foot care, isn't it? ... Or medical foot care? It can be either, CAN'T IT??? No! Podiatrists undergo a 2-year, state-recognised full-time training, or part-time training alongside their job that lasts a number of years. This training contains approx. $^1/_3$ practical lessons, $^1/_3$ practice in medical and podiatric institutions and $^1/_3$ theory.
If you look at the contents of the training, you will find that, apart from detailed knowledge of anatomy and physiology, particular emphasis is placed on pronounced technical and treatment knowledge in the areas of **diabetic foot syndrome** and **special pathology** throughout the entire training.
After successfully completing your training, podiatrists either work as independent service providers in their own podiatry practices (with or without a licence to provide health insurance treatment), as self-employed practitioners in a group practice, or as employees in hospitals or special outpatient foot clinics together with other professional groups, such as doctors, orthopaedic shoemakers and physiotherapists, occupational therapists, etc. If a company has a licence to provide health insurance treatment, podiatrists are also obliged to attend regular training courses within specified periods as part of this approval.

Fig. 6.1.1:
Hygiene is the top priority in podiatry treatments.

What does a podiatrist do exactly? Usually upon referral by a doctor, a podiatrist regularly checks the general condition of the patient's feet, in regard to the skin condition, pressure points and sensitivity (for example, tuning fork test) and is able to make an appraisal concerning the health of the feet and carry out the resulting foot "care" treatment, nail correction or pressure relief. Individual risk factors such as diabetes are properly taken into account using appropriate instruments, hygiene factors and product selection.
With the information obtained before, during and after the treatment (documentation required!), an interdisciplinary treatment and information concept is created for the respective patient, as well as a meaningful and intensive symbiosis between patient, doctor, diabetologist and, where applicable, wound manager.
As a result, individually tailored care, with the purpose of maintaining health and avoiding amputation, is possible and is coordinated perfectly to meet the needs of existing symptoms. Unfortunately, the expertise of a podiatrist is still frequently underestimated and its right to exist is called into question through ignorance and lack of information, or their services are not taken up as part of patient care. As a result, this leads time and again to the acceptance of the high cost of a, perhaps unnecessary, amputation of a part of the foot, and therefore to a loss of mobility and life quality for the patient.

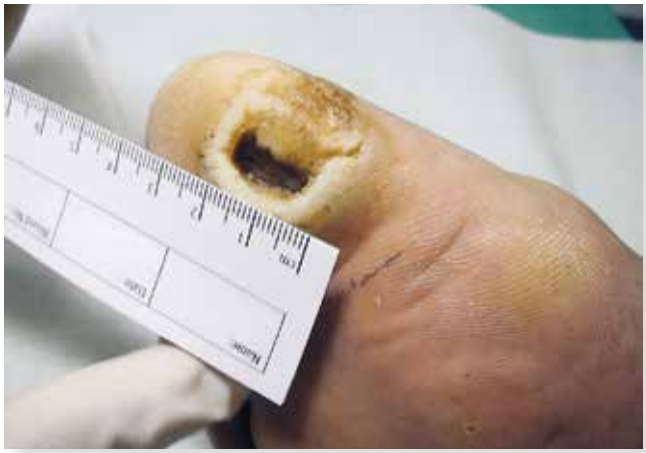


Fig.6.1.2:
Plantar hyperkeratosis in the region of D1 in case of DFU, that was not treated in time.

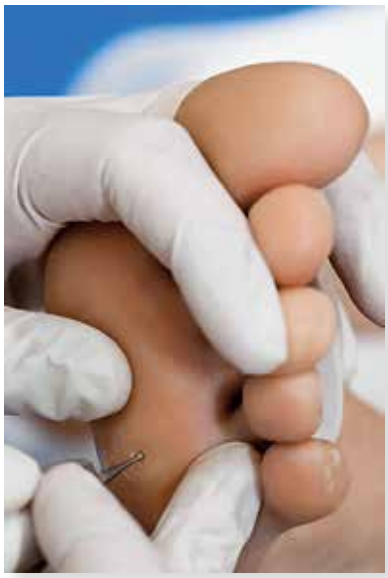


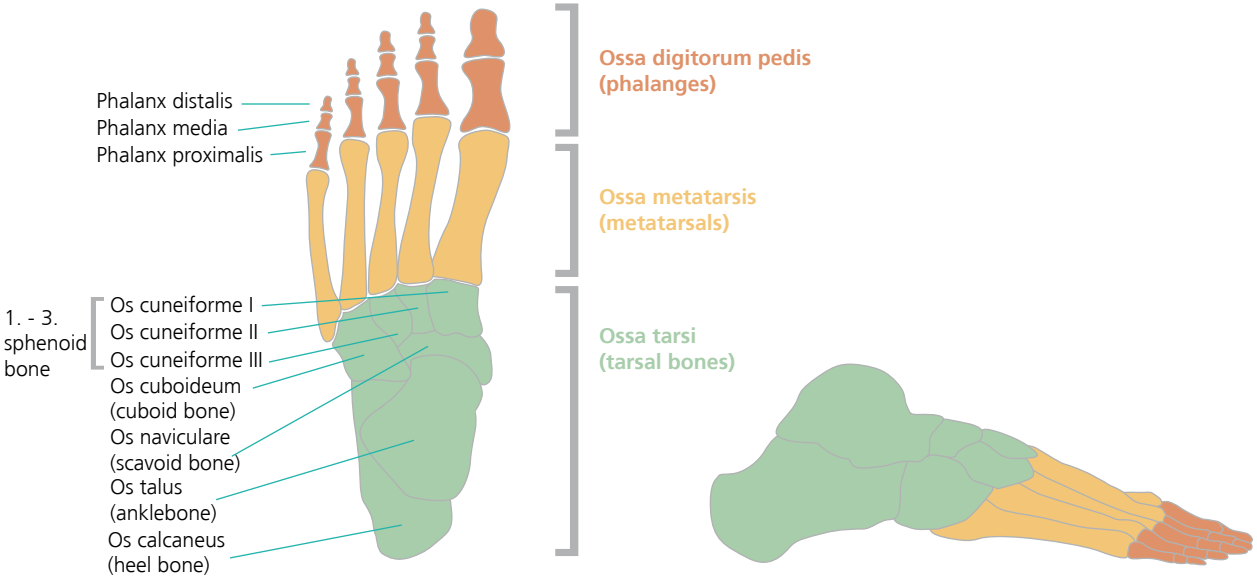
Fig. 6.1.3:
If not treated, a small and unconspicous corn (clavus durus) can lead to amputation.

"Diabetic foot syndrome (DFS) affects 15% of people with diabetes over the course of their lives (Reiber, Lipsky et al. 1998) and is a permanent condition. It demands a high toll from those affected and from society, as it leads to an impairment of mobility, long periods of illness, loss of work, amputations, loss of independence and even death. With about 2.5 billion euros/year in Germany (Hauner 2006), a majority of the expenditure for diabetes is caused by DFS. A greatly increasing part of the German population suffers from diabetes, currently over 7,000,000 people (Diabetes DE 2011). Worldwide, the number of people with diabetes has increased eightfold in the last two decades (IDF 2006), meaning there is often talk of a diabetes epidemic. The consequence is that a vast increase in cases with DFS have to be expected." (Source: AG Fuß der Deutschen Diabetes Gesellschaft, as of September 2012)

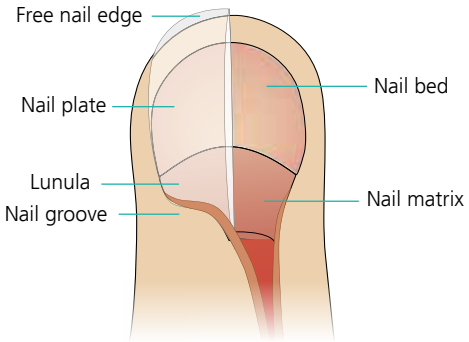
Summary:
Good, regular care of the diabetic foot and information provided by podiatrists, in close cooperation with the patient, the attending doctor and the wound carer, can prevent wounds from forming and amputations being necessary, both in the preventive and secondary preventive field.

5.6.2 The Basics of Anatomy and Pathophysiology for Podiatrists

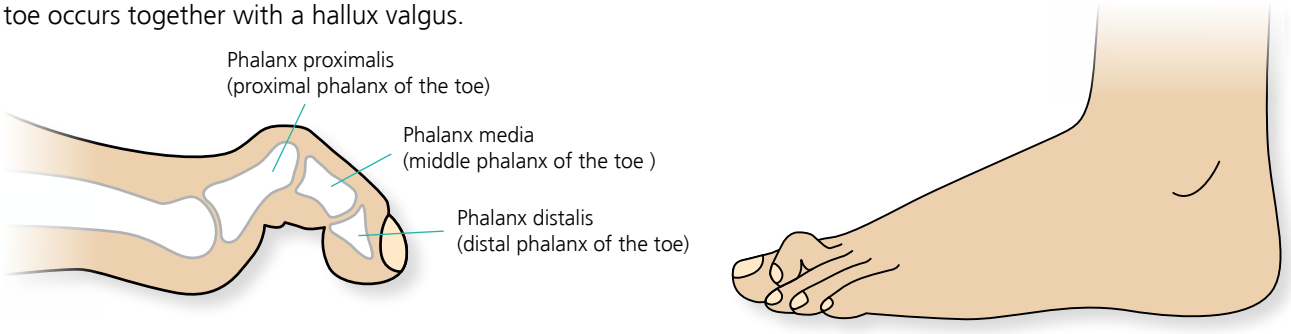
The foot is divided in the tarsus, metatarsus and forefoot (antetarsus). The foot skeleton consists of 7 tarsal bones, 5 metatarsal bones, 14 toe bones and 2 sesamoid bones, each of which is located under the first metatarsal head.



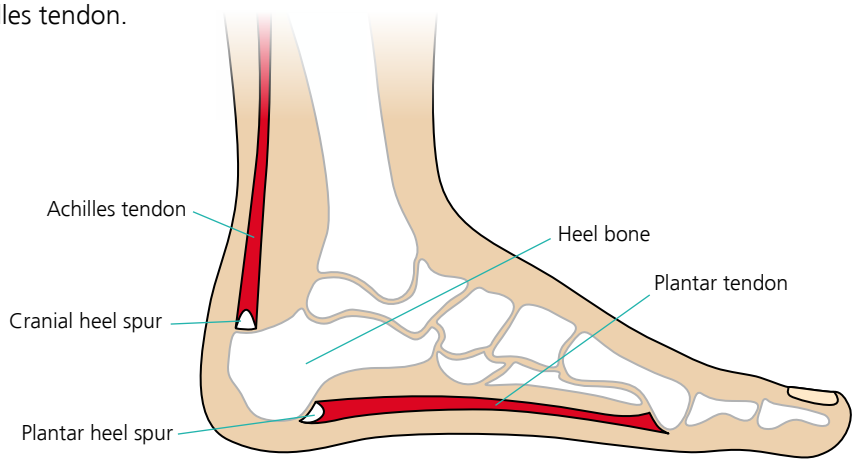
As skin appendages, **nails** are attached to the epidermis and are located on the tips of the fingers and toes.



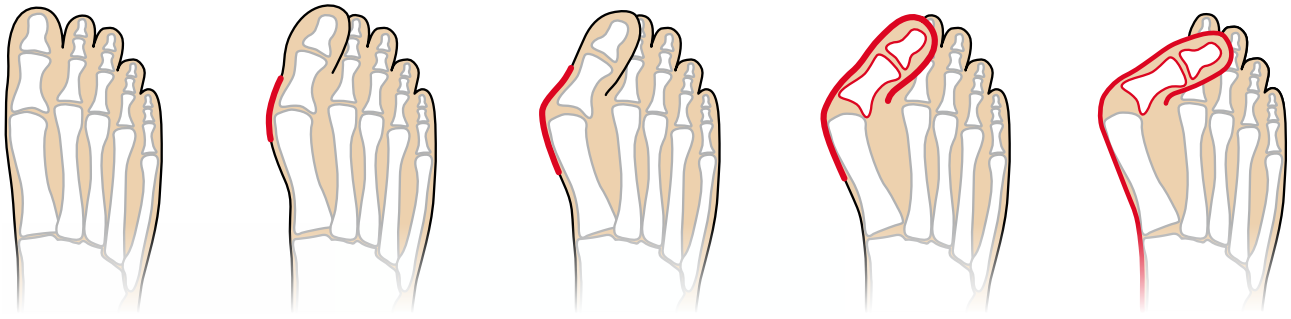
Both hammer and claw toe are malpositions, which mostly affect the second to fourth toes. If a toe hyperextends at the metatarsophalangeal joint, but bends at the middle joint and end joint, this is known as a **claw toe**. With a **hammer toe**, only the end joint is fully bent.
The most common cause for hammer or claw toe is wearing too tight or even too small shoes with a high heel. But also other deformities of the foot, such as splayfoot, flat foot and club foot can lead to hammer/claw toes. Other causes of hammer and claw toes can be neurological diseases or the consequences of an accidental injury. A genetic predisposition also plays a role in the development of a hammer/claw toe. Frequently the hammer/claw toe occurs together with a hallux valgus.



The heel spur (calcaneal spur) is a bony spur on the heel bone, which can be caused by excessive or one-sided strain. There are two types: the **plantar heel spur** is the far more frequent and is located on the underside of the heel bone. The spur is at the base of the tendon on the sole of the foot (plantar fascia) and points towards the toes. The **cranial heel spur**, however, occurs much less frequently and is located at the back of the heel bone, at the base of the Achilles tendon.



The **hallux valgus** is a deformity of the big toe with a deviated position of the big toe toward the second toe, at the same time as a deviation in the angle between the first and second metatarsal bones of the foot.
1st degree (≤ 20°): The ball of the foot protrudes slightly to the inside of the foot. There might be irritation and redness.
2nd degree (21° - 30°): The big toe begins to push over the second toe. Due to the irritation of the ball of the foot, pain and inflammation of the bursa can occur.
3rd degree (31° - 50°): The big toe is above or below the second toe. Additional overstretching of the tendons and irritation of the nerves. You start to walk on the outside of the foot.
4th degree (> 50°): The big toe is lies across the adjacent toes. The result is a severe splayfoot. Now, the rolling of your foot only occurs on the outside. At this stage, any movement causes severe pain.



Healthy foot | HV angle ≤ 20° | HV angle 21-30° | HV angle 31-50° | HV angle > 50°

5.6.3 Practical Use of LIGASANO® in Podiatric Practice

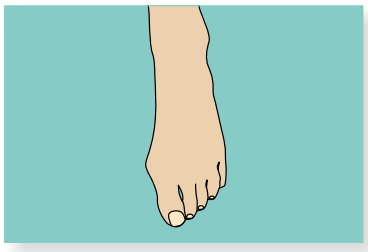
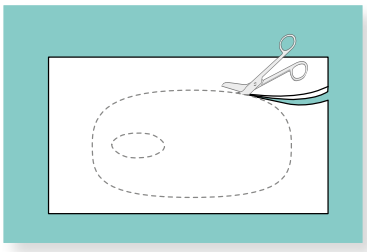
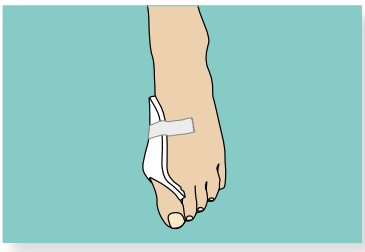
In everyday podiatry, LIGASANO® is preferably used in the following areas:

- Pressure and friction protection, e.g. for hallux valgus, heel spurs, toe deformities, or even interdigital
- Pressure protection after removing a clavus (corn)
- Tamponing of the nail fold, especially in case of unguis incarnatus (ingrown toenail)
- Subungual tamponade for nail fungus treatment caused by dermatophytes
- Interdigital in case of mycosis
- Care and prevention of diabetic foot syndrome (see also pages 57-60 in this brochure and in our brochure „Practical Experience Reports“)
- Absorption of excess sweat
- Inlays
- Forefoot and hindfoot relief
- As a spacer
- To promote local blood circulation
- In case of hypergranulation

Pressure Protection with LIGASANO® white in case of Hallux Valgus

To make the bandage pad, you need

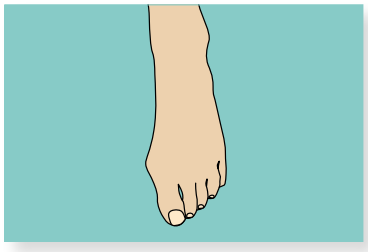
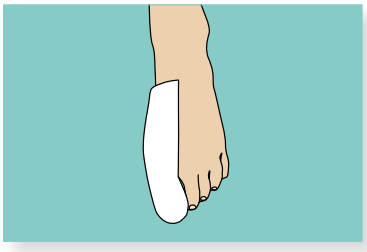
- 1 sheet of LIGASANO® white, at least 15 x 10 x 1 cm or 2 cm

Pressure Protection with Prefabricated Hallux Valgus Bandage made of LIGASANO® white

For manufacturing you need

- 1-2 pieces of Hallux valgus bandage made of LIGASANO® white, sterile or non-sterile

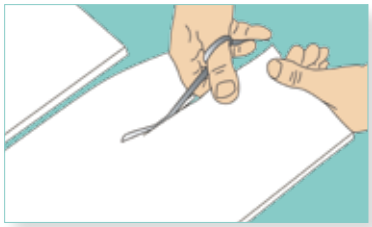
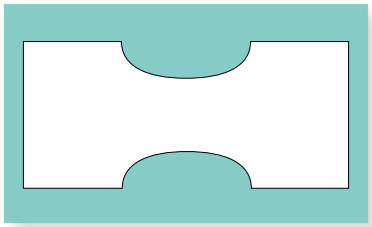
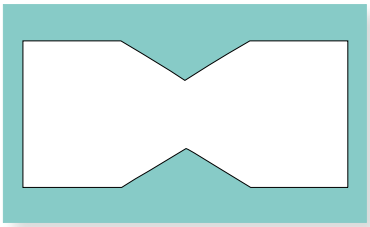




Pressure protection with LIGASANO® white for heel spur

Cave: The use of LIGASANO® white is not recommended as a long-term cushion for the plantar heel spur due to its decreasing compressive tension.

For manufacturing you need

- 1 sheet of LIGASANO® white, at least 15 x 10 x 2 cm

Instead of the curves, wedges can also be cut out.

Pre-fabricated dressing pad for heels for treatment and / or prevention of heel lesions
Therefore you need

- 1 piece LIGASANO® white sterile or unsterile, heel dressing Ø 20 cm, thickness 1cm, with adhesive edge

Link to the video:
heel dressing

Application techniques:

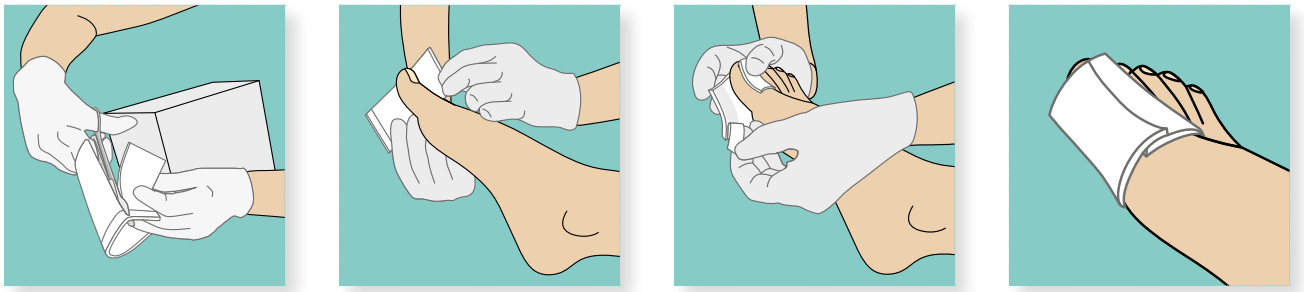
In case of **mainly bedridden** patients please put the overlap on the backside of the heel.

In case of **mainly sitting or standing** patients the overlap has to be on the plantar side of the heel.

Usage of the LIGASANO® toe dressing with adhesive edge in the podiatric practice

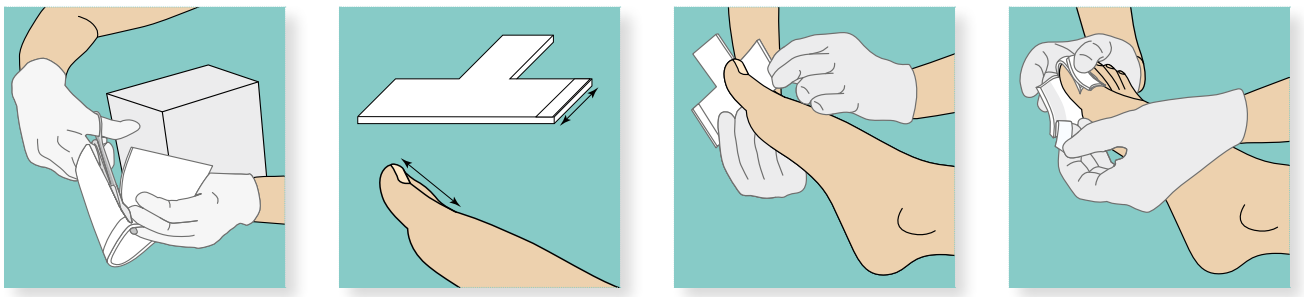
For the **manufacturing of a tube for toes** you need

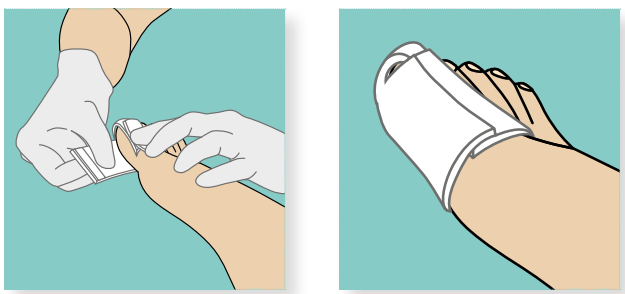
- LIGASANO® white dressing for toes with adhesive edge, ca. 8-10 cm



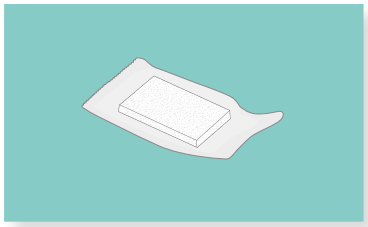
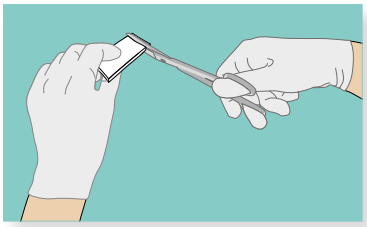
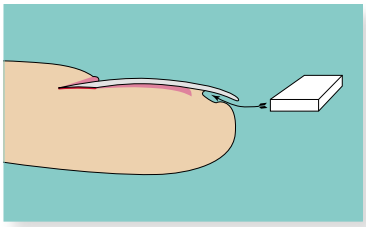
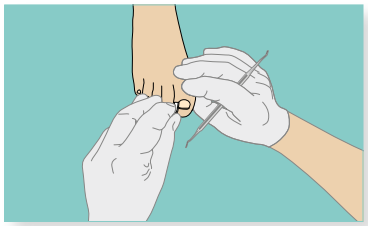
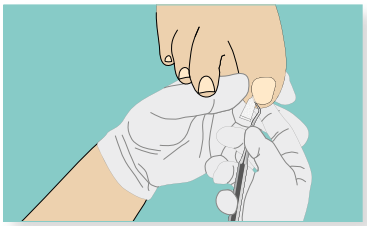
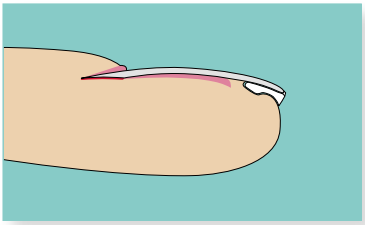
For the **manufacturing of a cap for toes** you need

- LIGASANO® white dressing for toes with adhesive edge, ca. 8-10 cm



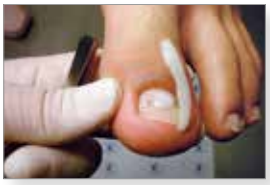
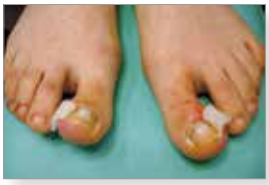


Underpadding with LIGASANO® white in case of treatment of unguis incarnatus
Therefore you need
- 1 piece LIGASANO® white sterile, size 6 x 2.5 x 0.4 cm

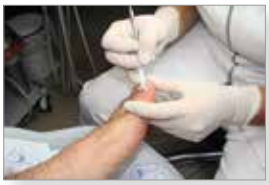







Practice example: underpadding with LIGASANO® white for the treatment with orthonyxia technology (3TO orthonyxia)

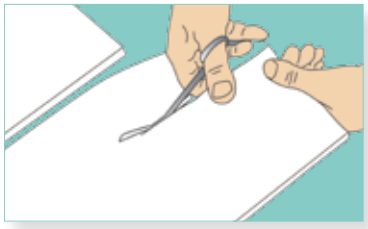
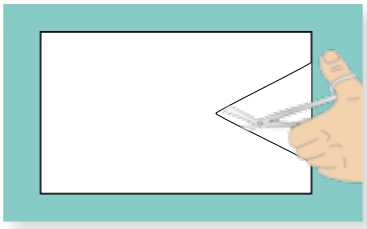


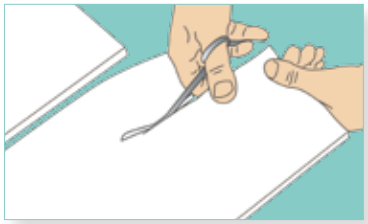
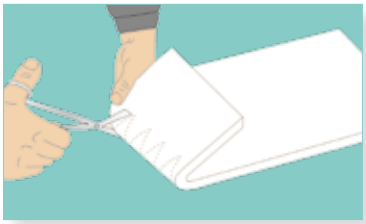
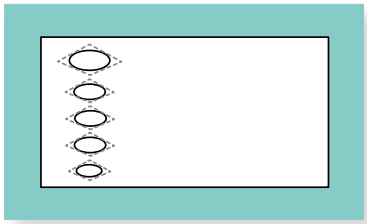
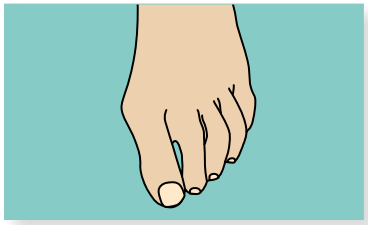


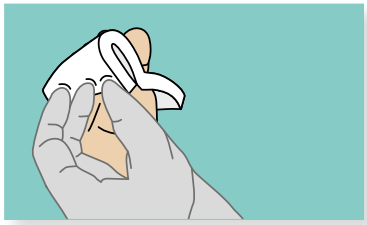


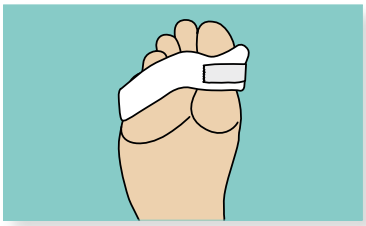
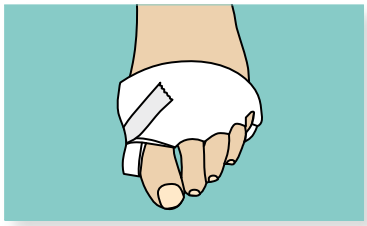
Avoidance of the direct contact of skin layers as a prophylaxis or therapy of intertrigo
Therefore you need
- 1 piece LIGASANO® white, size 15 x 10 x 2 cm


Protection against pressure and friction in case of hammer toes and claw toes
Therefore you need
- 1 piece LIGASANO® white, size 15 x 10 x 1 cm

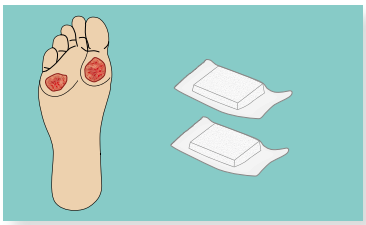
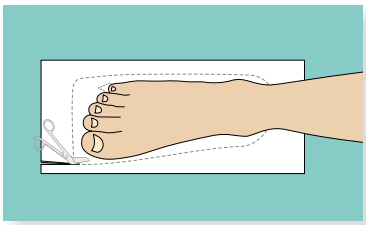
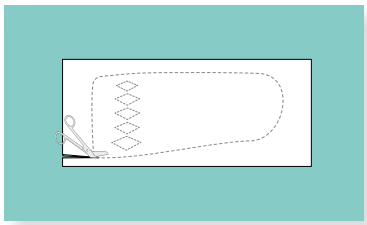
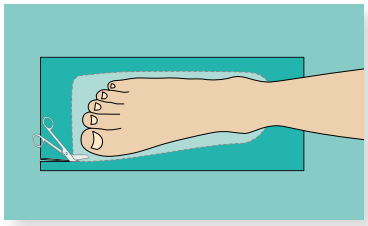
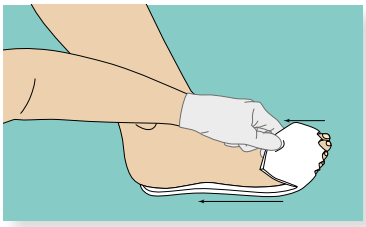
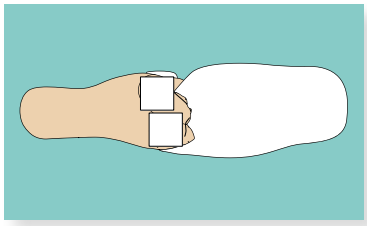
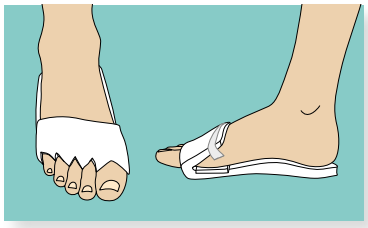





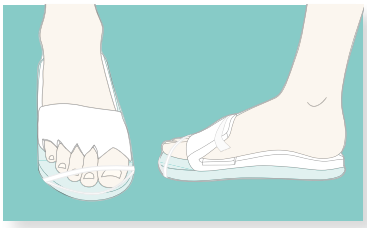


Alternatively you can applicate our prefabricated hammer toe dressing (art. no. 15078-012).

Wound treatment and pressure relief in case of malum perforans:
Therefore you need e.g.
- 1-2 pcs. LIGASANO® white sterile, size 5 x 5 x 1 cm
- 1 OP LIGASANO plantar dressing for diabetics

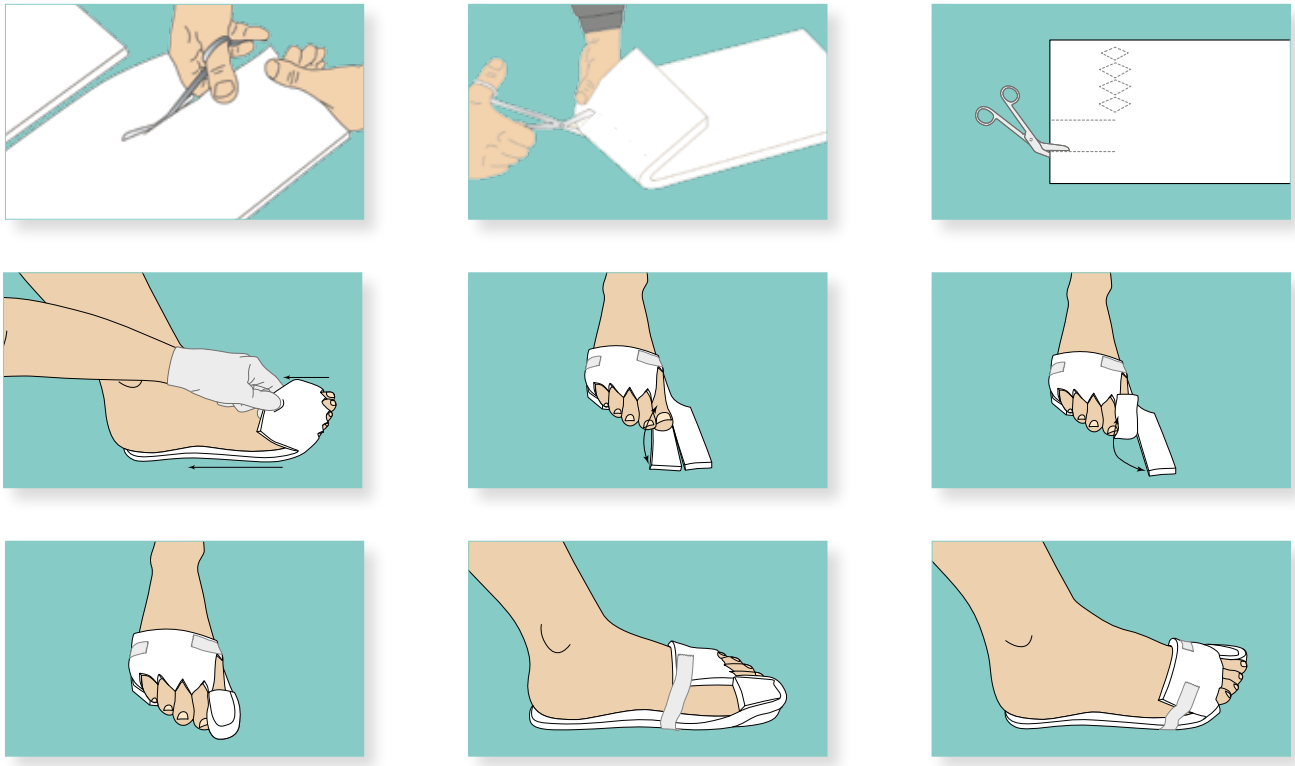










Pressure relief by pressure distribution, protection against pressure and friction, therapy of intertrigo

Therefore you need

- 1 piece LIGASANO® white, size 59 x 49 x 1 cm

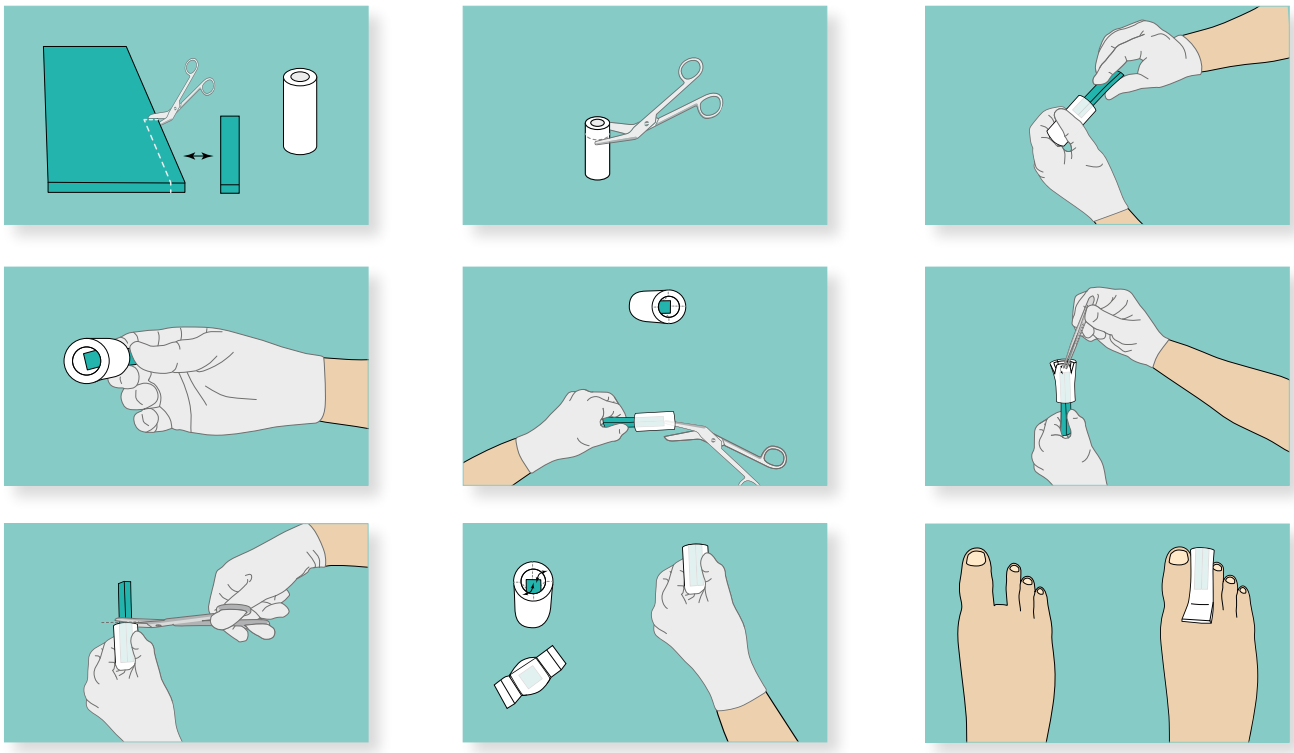


If necessary, it is possible to pad additionally with a sheet of LIGASANO® white or LIGASANO® green, e.g. with the plantar dressing for diabetics (art. no. 15098-007).

Tube for toes, filled with LIGASANO® green as a placeholder after amputation

Therefore you need

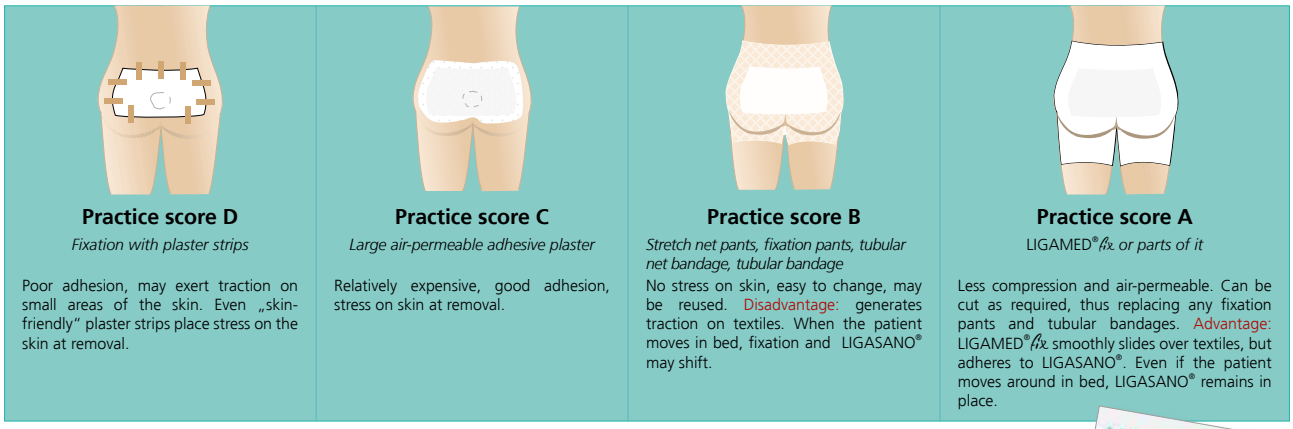
- 1 tube for toes, made of LIGASANO® white, large (Ø 3.5 cm) or small (Ø 2.5 cm)
- 1 small piece of LIGASANO® green



7 Aids for Fixation and Positioning

7.1 Fixation Aid

The fixation of LIGASANO® white must always be permeable to air, never occlusive. Subsequently please find some possibilities:



Practice score D

Fixation with plaster strips

Poor adhesion, may exert traction on small areas of the skin. Even „skin-friendly" plaster strips place stress on the skin at removal.

Practice score C

Large air-permeable adhesive plaster

Relatively expensive, good adhesion, stress on skin at removal.

Practice score B

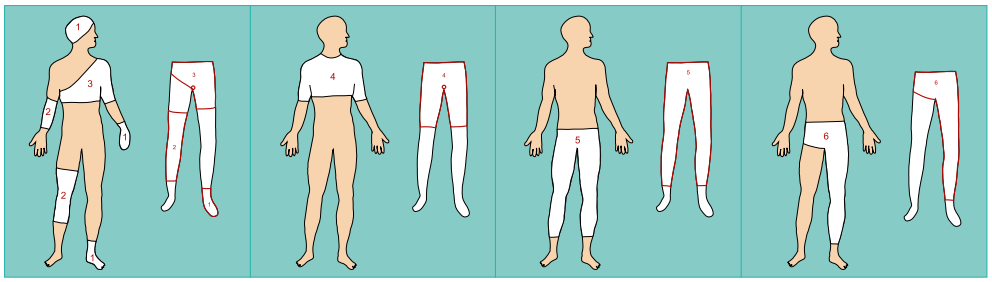
Stretch net pants, fixation pants, tubular net bandage, tubular bandage

No stress on skin, easy to change, may be reused. Disadvantage: generates traction on textiles. When the patient moves in bed, fixation and LIGASANO® may shift.

Practice score A

LIGAMED® *fix* or parts of it

Less compression and air-permeable. Can be cut as required, thus replacing any fixation pants and tubular bandages. Advantage: LIGAMED® *fix* smoothly slides over textiles, but adheres to LIGASANO®. Even if the patient moves around in bed, LIGASANO® remains in place.



Art. no. 10305-003

LIGAMED® *fix* is a practical non-adhesive fixation aid for LIGASANO® all over the body. It affords you high wearing comfort, is easy to adapt and often manifold utilisable. Many applications with adhesive plaster and their well-known disadvantages are avoidable by this fixation aid.

Field of application	Fixation of LIGASANO®, e.g. • For wound healing and concomitant treatment • For local promotion of blood circulation, pressure relief + padding • At intertrigo and fungal infections (hygienic prevention + therapy) Further examples result from the LIGASANO® instruction sheet
Medical advantages / Comfort	• No skin irritation by adhesives, well compatible with skin • Permeable to air, no accumulation of heat and moisture, prevents maceration of skin • No slipping, reduces shearing forces • Hardly compression / dents • Removal without any pain (not adhesive)
Technical advantages	• Usability is not addicted to temperature (you can use it both in summer and winter) • Resistant to wet and moisture
Fixation method	• No necessity to relearn, application like stretch net pants or tubular bandages • With scissors easily cut to fit
Design / Material	• Form of a tight, but without gusset and seams • Smooth fabric with 20 denier, completely permeable to air • Hardly addiction to fray at the cut selvedges • 97% polyamide, 3% spandex • Treated with silicone for better slippage on textiles • Laundered, damped, ÖKOTEX 100 standard
Function of Fixation	• Slips on textiles (sheets, underlays for patients, clothing) by a special kind of weaving + conditioning with silicone • Adhesive by friction to LIGASANO® white and LIGASANO® green • All in all LIGASANO® can fixed on the body often without adhesive plaster strips
Environmental relevance / Disposal	• Depending on the application manifold utilisable and washable • Little need of material (1 piece of LIGAMED® *fix* = approx. 15 gram) • Disposal as household waste
Cost effectiveness	• Low product price, no expiry date - no wastage by deterioration • Quick, easy, flexible application • Often multiple usable • Substitutes a lot of other fixation aids

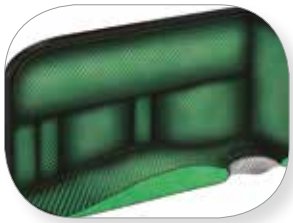
Important instruction: Whether the use of LIGAMED® *fix* is expedient and indicated, it has to be decided individually in every single case from the responsible user. Where required you have to check afore, if the desired results are reached and if there develop no inacceptable disadvantages. All information and contemplated facts conform to our knowledge, errors excepted.

7.2 Heel Shoe

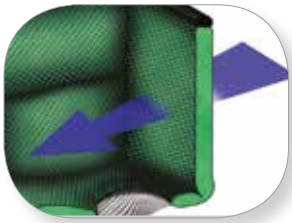
The original LIGAMED® Heel Shoe and the LIGAMED® Heel Shoe Plus protect the whole foot in a perfect way against pressure, decubitus, and accumulation of heat and moisture.

LIGAMED® Heel Shoe
Art. no. 32210-001

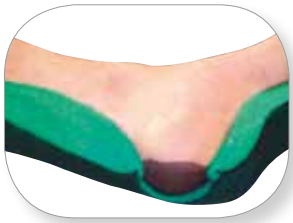
LIGAMED® Heel Shoe Plus
Art. no. 32211-001



Its inner life consists of **LIGASANO® green**, which is internationally approved in medicine, its cover of a very strong polyamide grid fabric. The size of the heel shoes are L x W x H **27,5 x 9 x 18 resp. 23 cm**.

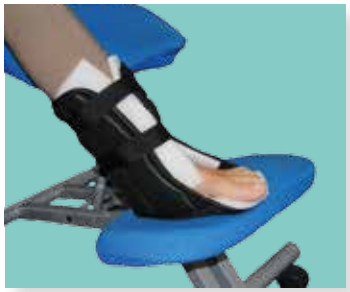


The both original **LIGAMED® Heel Shoes** are completely permeable to air and light as a feather. No accumulation of heat and moisture, you hardly feel to wear it.



The three-dimensional padding is anatomically accurate. The result is an optimal protection, no pressure spots, a perfect fit (also in the case of anomalies), high wearing comfort at almost every size and form of feet.

The fastening of the heel shoes is quick and easy. The fixation takes place in seconds with two extra long Velcro® fasteners and can adjust at will.



Application tip:

The both original LIGAMED® Heel Shoes **+ LIGASANO® white, 1 cm thick** are an ideal combination. By this you use the therapeutical effect of LIGASANO® white and the heel shoe remains clean for a long time - that saves time and money.

Places of use	Field of application	Protection	Comfort	Hygiene
• Clinic + care • Operation table • Medical check-up • Intensive care • Nursing home • Nursing service • General care • Bed, wheel chair etc. • Transport of patients • At home • Permanently temperature-resistant at temperatures between -20 °C and +60 °C	• Fixation of wound dressings • Accompanied wound treatment • Prevention • Pressure ulcer on heels • Ankles • Ideal for diabetics • No known application risks and contra-indications • LIGAMED® Heel Shoes are **not walking shoes**	• Protection against pressure and knock for the whole foot in lying and seating positions • Protection against fungal infections and moist feet • No hyperthermia • Reduction of shearing forces	• Completely permeable to air • No hyperthermia • No accumulation of moisture • Featherweight • Anatomic-like formed • Fits big and small feet • High wearing comfort • Maintenance-free	• Rejection of dirt, drying very fast • Washable up to 95° C with common house-hold detergents • Disinfection by boil program of a washing machine • Sterilisable with steam at 134° C for 5 minutes • Disinfectable with common household disinfectants, which are free of alcohol and chlorine • No medium for fungi and bacteria

8. Advanced Training and Service

8.1 Inhouse Trainings:

Die LIGAMED® Inhouse courses are informative and exciting. Indeed, we cannot renounce for the "less exciting" theory, but the practical part will balance it entirely. We teach you how to make chronic wounds to healing wounds by treating the patient with care. And how to reach an effective prevention against this kind of wounds by using simple means.
Our courses are an absolutely necessity if you are engaged with the treatment of chronic wounds and the care of temporarily or permanently immobile patients.

Title / Seminar content	Duration	Number of participants	Adapted for
Practical basic course „LIGASANO® Therapy + Prevention with system" • Systematic for reliable healing of chronic wounds • A better and more individual prevention + hygiene with little expenditure of time and less costs Concentrated information in a compact and practical course. The following subjects are treated: Particularly pressure ulcer, ulcus cruris, diabetic caused lesions, under special consideration of the meaning of sufficient blood supply and appropriate nutrition. Physical and biological principles, case history, diagnosis, techniques of bedding and bandaging, promotion of pressure resistance of the patients, pressure release, skin care, wound cleaning, examples for effective application.	ca. 180 minutes	Not less than 10, optimal are 20-30 participants	Physicians and nurses in hospitals, nursery homes, schools The access into the LIGASANO®-Therapy or as a refresher course
Basic course „Podiatry / Diabetology" Concentrated information in a compact and practical course. The following subject are treated: • Application of LIGASANO® white (e.g. on diabetic caused lesions of the feet or inflamed nail folds) • Preventive measures with LIGASANO® white and LIGASANO® green (e.g. pressure protection and antifriction in case of hallux valgus, dry rhagades, clavus mollis, hygienic measurements of fungal infections)	ca. 120-180 minutes	optimal are 10-20 participants	Podiatrists and pedicurists, vocational schools for podiatrists The access into the LIGASANO®-Therapy or as a refresher course
Advanced courses (workshop format) Subjects and duration are decided by the participants. Examples are: • Wound treatment and prevention measures on the patient • Discussion and deepening knowledge for particular applications In order that the lecturer is able to prepare the subjects, please name the desired main focuses already with booking.	ca. 120-180 minutes	optimal are 5-10 participants	Only for LIGASANO® users with knowledge and practice of the basic course

Our professional and experienced speakers lecture about 400 courses every year, in most cases with phenomenal success, as shown by the evaluations of the participants.
Ask for your desired date! See the application form on the next page. If you want to save paper please find an application form at **www.ligasano.com** to send via e-mail. **We look forward to see you!**

State July 2023	1 excellent	2 good	3 satisfactory	4 sufficient	5 unsatisfactory	6 very poor	Ø average
Content:							
-quality of content	75.07%	22.64%	1.63%	0.28%	0.17%	0.21%	1.28
-practical usability	74.72%	21.56%	2.41%	0.77%	0.26%	0.28%	1.31
-useful information	83.25%	13.71%	2.16%	0.39%	0.24%	0.25%	1.21
Speaker:							
-competence	82.35%	15.79%	1.09%	0.31%	0.20%	0.26%	1.21
-understandability	81.50%	16.55%	1.41%	0.16%	0.14%	0.24%	1.21
Length of the seminar:	perfect grade 1	little too short grade 3	little too long grade 3		too short grade 6	too long grade 6	
	86.51%	2.01%	9.09%		1.46%	0.93%	1.34
						Total Ø	1.26

Course Registration - Copy Sheet

Valid only inside Germany. If you want to register for a course in other countries, we would like to send you a contact address in your country.

By post or by fax to +49-9103 27 96

LIGAMED® medical Produkte GmbH
Advanced Training & Courses
Pfannenstielstr. 2

90556 Cadolzburg, Germany

We are glad if you answer the following questions:

☐ We use LIGASANO® since _____ .

☐ for wound treatment ☐ for positioning

☐ Hitherto we did not know LIGASANO®

☐ We became aware of LIGASANO® by:

_____

_____

We accept your offer and ask you to check if you can hold on _____ at _____ o´clock

or alternatively on _____ at _____ o´clock

the following course at our institution (please mark with a cross). We calculate with about _____ participates.

- ○ Basic course, universal (180 minutes)
- ○ Basic course, podiatry (120-180 minutes)
- ○ other topics:

_____

_____

- ○ Workshop wound treatment (120-180 minutes)
- ○ Workshop prevention / positioning (120-180 minutes)
- ○ Workshop podiatry (120-180 minutes)

If one of the both fixed dates is practicable, you will receive a confirmation from us immediately by post, fax or email. If none of the both fixed dates is possible, we contact you, finding a date that is possible for both sides.

Sender:

Please fill out in block letters

_____
Name of the organisation

_____
Street, house no. Postcode, town

_____
Responsive person Tel. Fax

_____
Place of event (only if different from above named eddress)

_____
Place, date Signature

8.2 Webinars

Since 2022, we also offer webinars on all topics related to wound care and prevention. Currently only in German.
Our expert speakers will inform you on general topics as well as on the application of LIGASANO® in different wound types or wound conditions and on prevention.

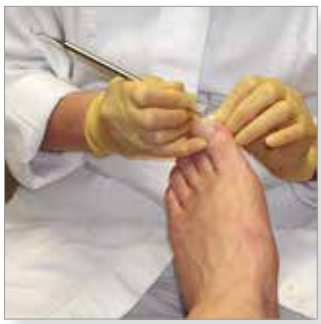
You can find current webinar dates on our website
https://www.ligasano.com/de/veranstaltungen/webinare

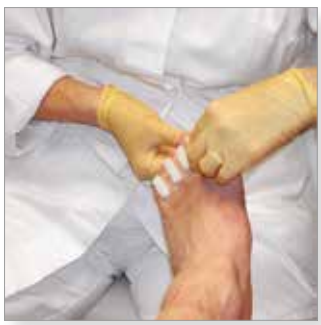
There you can also view past webinars.

8.3 On-Site Consultation

You can inform yourself about our products on several fairs and congresses and in our continuing education courses (annually ca. 400 courses in Germany). For actual dates of courses and participations at fairs respectively congresses please see our web presence **www.ligasano.com**

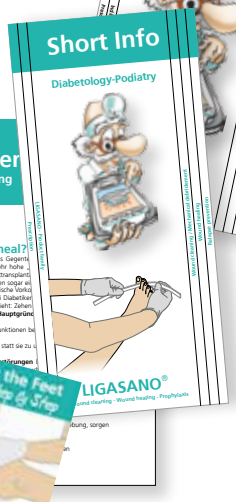
Nevertheless it is a different matter if you have to treat a patient and you are at first doubtful how to use LIGASANO®. If you have questions regarding wound treatment, positioning or hygiene, please contact us by telephone **(+49 - 9103 / 2046**) or by email (**info@ligamed.de**). We try to help you immediately with a telephonic or written advise. In many countries we have distributors, which may support you with guidance on-site.





8.4. Practical Helps

Our folders **short information** and **short information for diabetology/ podiatry** show you quick and clear the desired information. There you find the most important facts regarding wound treatment, pressure relief/prevention, fixation, indication, prescription and the use in diabetology/podiatry.

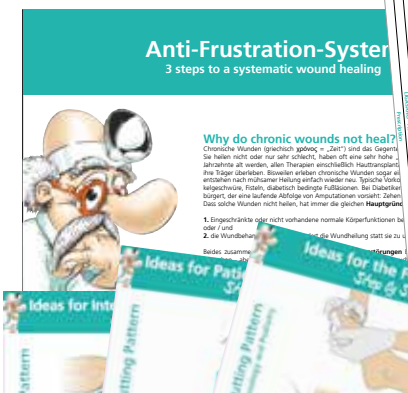


Art. 02042

Art. 02072

The leaflet "**Anti Frustration System**" shows you the three steps to a systematic wound healing:
- Anamnesis+diagnosis
- Treatment of wound healing impairments
- Wound treatment without hindering the healing

Additional it shows you, that not the wound treatment but the wound healing is your real aim.



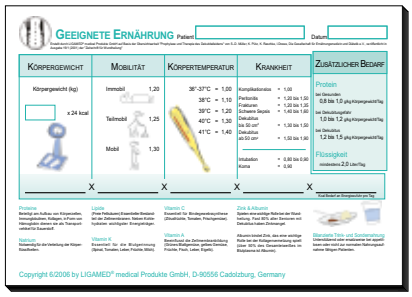
Art. 05012

Art. 05082

Individual pressure relief with LIGASANO®: We show you step by step how it works - in our three **pattern booklets**.
In it you will find suggestion for the positioning of the whole body, recommendations for pressure relief and pressure distribution of head, hands, buttock, feet, for intertrigo prophylaxis and others. For normal ward and intensive care unit.
The handy booklets fit perfectly into the smock pocket. Thus you always have it quick at hand, if needed.

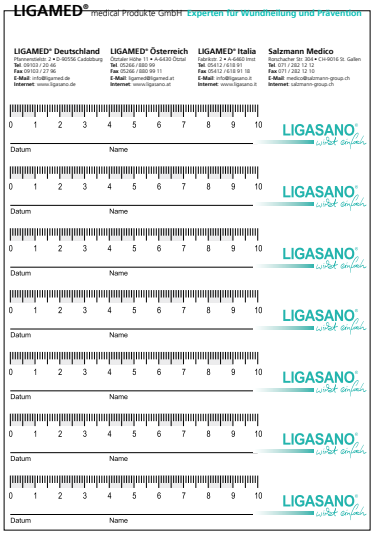
Art. 05032 Art. 05091

A further important implement for the day-to-day care is our **calculation sheet** for appropriate nutrition, to calculate the individual energy need of your patients. Often this need is higher than assumed, especially if chronic wounds, e.g. a pressure sore, exist. Try it!

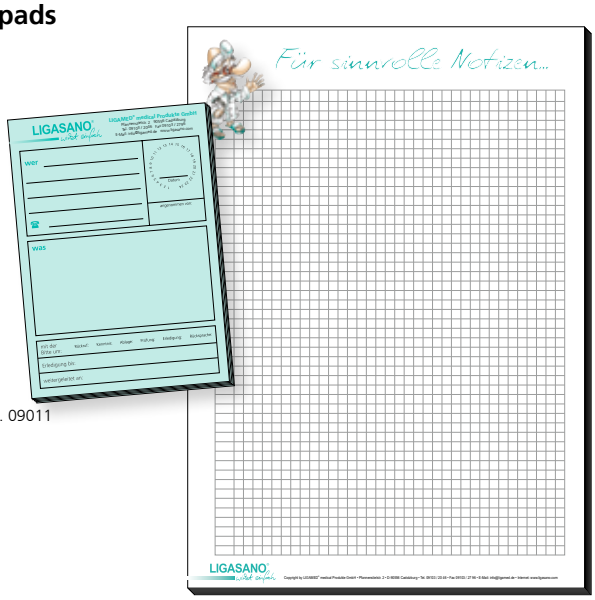


Art. 05022

Wound rulers are always useful, as well as **note pads** and **writing pads**.



Art. 05040



Art. 09011 Art. 09061

In usual quantities we send our little auxiliaries to your institution for free. For this please use our order form at page 101 or send us an email to **info@ligamed.de**. If you are e.g. retailer/distributor and need higher quantities, we sell it to you at our cost.

8.5 Nutrition Calculator

Please keep in mind: **No wound healing without appropriate nutrition!**
Often the wound healing fails for lack of proper and sufficient nutrition - and this on the other hand often for lack of knowledge of the need. A typical example: the wound is clean and without problems, but shows no or less tendency for granulation. This may be a distinctive indication for basic malnutrition or only deficiency of proteins or zinc. On the data base of „The Society for nutrition medicine and dietetic“ in Aachen/Germany (www.ernaehrungsmed.de) we have designed the calculation sheet „Appropriate Diet“, by which you can find out easily the individual need of your patients.

Copy sheet

APPROPRIATE DIET Patient _____ Date _____

Written by LIGAMED® medical Produkte GmbH on the basis of the summary "Prophylaxis and therapy of the decubital ulcer" by S.-D. Müller, K. Pütz, K. Raschke, I.Drewe, Die Gesellschaft für Ernährungsmedizin und Diätetik e.V.,published in issue 19/1 (2001) "Zeitschrift für Wundheilung" (Wound Healing Journal)

BODY WEIGHT	MOBILITY	BODY TEMPERATURE	ILLNESS	ADDITIONAL NEED
body weight (kg)	immobile 1.20	36°-37°C = 1.00	no complications = 1.00	protein
_____ x 24 kcal	partially mobile 1.25	38°C = 1.10	peritonitis = 1.20 to 1.50	in healthy patients 0.8 to 1.0g/ kg body weight/ day
	mobile 1.30	39°C = 1.20	fractures = 1.20 to 1.35	in patients with decubitus risk 1.0 to 1.2g/ kg body weight/ day
		40°C = 1.30	severe sepsis = 1.40 to 1.60	in patients with decubitus 1.2 to 1.5g/ kg body weight/ day
		41°C = 1.40	decubital ulcer up to 50 cm² = 1.30 to 1.50	liquid
			decubital ulcer greater than 50 cm² = 1.50 to 1.90	at least 2.0 ltr/day
			intubation = 0.80 to 0.90	
			coma = 0.90	

_____ X _____ X _____ X _____ X _____ kcal energy need per day

Proteins
Important for the formation of the body's cells, immune globulins, collagen; as haemoglobin they are the body's means to transport oxygen.

Sodium
Required for the distribution of the body's fluids.

Lipids
(Free fatty acids) Essential component of the cell membranes. Most important provider of energy, together with carbohydrates.

Vitamin K
Essential for the coagulation of blood (spinach, tomatoes, liver, fruits, milk).

Vitamin C
Essential for the synthesis of connective tissue (citrus fruits, tomatoes, fresh vegetables)

Vitamin A
Affects the formation of cell membranes (green leafy vegetables, yellow vegetables, fruits, fish, liver, egg yolk)

Zinc & Albumin
Play an important role in wound healing. Almost 80% of all elderly who suffer from decubital ulcers have zinc deficiency.

Albumin bonds zinc, which plays an important role in the interlinking of collagen. (more than 50% of the total protein content in blood plasma is albumin)

Balanced drinkable and special food
Supplementing food, or as replacement for patients without appetite, or patients incapable of ingesting normal food

You can order this calculation sheet for free as a pad with 10 single sheets from us at tel. +49 (0)9103 / 20 46, by fax at +49 (0)9103 / 27 96, by e-mail to info@ligamed.de or with the order form on page 107.

8.6 Expert Standard “Nutritional Management“

The “Expert Standard Nutritional Management to Ensure and Promote Oral Nutrition in Healthcare“ should help to prevent malnutrition or fix malnutrition that has already manifested.
Nutritional problems in old age are, for example, decreased appetite, problems with teeth or dentures and the associated chewing difficulties, dysphagia (swallowing disorders), etc.

Objective of the Expert Standard Nutritional Management:
“For each patient/resident who requires care, oral food intake corresponding to their needs and requirements are ensured, counteracting any impending or existing malnutrition.

Reasoning: Eating and drinking influence the quality of life, are important components of social and cultural identity and help to maintain health through nutrient intake. Securing a needs-based and demand-based diet can prevent malnutrition and counteract any existing deficits through the early detection and evaluation of signs of an impending or existing malnutrition and its causes, through appropriate support and adjustments, specific measures and a suitable supply of food."

Structure	Process	Result
S1a - **The nurse** has the skills to identify signs of impending or existing malnutrition (screening) and to carry out a more in-depth assessment of the nutritional situation and any influencing factors (in-depth assessment). **S1b - The facility** ensures that appropriate instruments and tools are available for assessment and documentation.	**P1** - **The nurse** records any signs of impending or existing malnutrition (screening) for all patients/residents at the start of the nursing assignment as part of the care anamnesis, in the event of acute changes and at individually determined intervals. If there are signs, they perform a more in-depth assessment of the nutritional situation and the influencing factors (in-depth assessment).	**R1** An up-to-date screening result is available for all patients/residents. An in-depth assessment takes place for patients/residents with signs of impending or existing malnutrition.
S2a - **The nurse** has specialist knowledge of planning and controlling interdisciplinary measures to ensure needs-based and demand-based nutrition, including the competence to make decisions on ethically complex issues. **S2b - The facility** has a multi-professional procedural regulation for cross-professional cooperation in nutrition management.	**P2** - **The nurse** coordinates measures based on the procedural regulation in close cooperation with other professional groups involved with the aim of providing individually adapted nutrition management.	**R2** The multi-professional measures are coordinated and, if necessary, ethically justified.
S3a - **The nurse** has the skills to design the plan for individual meal times and interactions. **S3b - The facility** has a suitable concept for food provision.	**P3** - **The nurse** plans, together with the patient/resident and their family members, activities to support food intake, adapt the environment, organise suitable, flexible choices of food and drink and dosage forms and incorporates other groups of professionals as necessary.	**R3** An individual action plan is available to ensure a needs-based and demand-based diet.
S4a - **The nurse** has specific skills to support food intake, including handling special risk situations and specific impairments. **S4b - The facility** provides appropriate staffing and personnel resources to ensure need-and-demand based nutrition management. It ensures suitable spatial requirements for meals and interactions that are focussed on the patient/resident.	**P4** - **The nurse** guarantees support encouraging self-determination and independent activity of the patient/resident and motivating interactions and surroundings during mealtimes. They take into account any special health problems of patients/residents.	**R4** The patient/resident has received extensive and professional support to ensure a needs-based and demand-based diet during and outside of the usual mealtimes. The environment at mealtimes corresponds to the needs and requirements of the patient/resident.
S5 - **The nurse** has information, advice and guidance skills to ensure a needs-based and demand-based diet.	**P5** - **The nurse** informs and advises the patient/resident and their family members on the development and consequences of malnutrition and the options of adequate nutrition and provides guidance to implement measures where appropriate.	**R5** The patient/resident and their relatives are informed, advised and, if necessary, instructed about the development and consequences of malnutrition and about possible measures.
S6 - **The nurse** has the skills to assess the appropriateness and effectiveness of the measures taken.	**P6** - **The nurse** checks, together with the patient/resident and their family, the success and the acceptance of the measures at individually defined intervals and will, if appropriate, carry out a reassessment and corresponding changes in the plan of measures.	**R6** The patient/resident has no signs of impending or existing malnutrition, as far as this is possible through demand-based and needs-based oral food intake.

Table from: Deutsches Netzwerk für Qualitätsentwicklung in der Pflege (German Network for Quality Development in Nursing) (Ed.): Expertenstandard Ernährungsmanagement zur Sicherstellung und Förderung der oralen Ernährung in der Pflege, 1st update 2017

Order Sheet - Copy Form for Fax and Postage

By letter post or by fax to +49-9103/2796

LIGAMED® medical Produkte GmbH
Customer Service
Pfannenstielstr. 2

90556 Cadolzburg, Germany

Sender:

_____
Institution, Company

_____
Name, First name

_____
Street, House No.

_____
Postal Code Town

_____
Tel. Fax e-mail

☐ Yes, I want to receive every actual issue of
Dr. Guck´s Compendium Wound Cleaning-Wound Healing-Recurrence Profilaxis

Please send me additionally for free

_____ pcs. More issues of Dr. Guck´s Compendium Wound Cleaning-Wound Healing-Recurrence Prophylaxis (**item no. 03012**)

_____ pcs. Anti Frustration System - Three steps to a systematic wound healing (**item no. 05012**)

_____ pcs. Brochure Practical Experiences and Studies (**item no. 08202**)

_____ pcs. Pads of our nutrition calculation sheet à 10 sheets in size 210x148mm (**item no. 05022**)

_____ pcs. Short info LIGASANO® for physicians and nursing stuff (**item no. 02042**)

_____ pcs. Short info LIGASANO® for podiatrists (**item no. 02072**)

_____ pcs. Booklet with patterns „Ideas for Nursing“ (**item no. 05032**)

_____ pcs. Booklet with patterns „Ideas for Intensive Care“ (**item no. 05082**)

_____ pcs. Booklet with patterns „Ideas for the Feet“ (**item no. 05092**)

_____ pcs. Flyer Original LIGAMED® Heel Shoe (**item no. 02032**) and Heel Shoe Plus (**item no. 02032+**)

_____ pcs. Sore ruler (**item no. 05040**)

_____ pcs. Note pads (**item no. 09011**)

_____ pcs. Writing pads (**item no. 09061**)

_____ pcs. **Information folder with all above named brochures and samples**

Please send **Dr. Guck´s Compendium** also to:

_____
Institution, Company

_____
Name, First Name

_____
Street, House No.

_____
Postal code Town

_____
Tel. Fax e-mail

Glossary

Abbrevations: abbr. = abbrevation; adj. = adjective; pl. = plural; syn. = synonym

actin filaments
wiry protein structures in eucaryotic cells; consist mainly of the protein actin
activated carbon
medical charcoal, consisting of porous, fine-grained carbon
adhesion, intercellular
attachment of cells to proteins of the extracellular matrix
afferent
leading to an organ
alginate
salt of alginic acid
alginic acid
structuring element of the cell walls of brown algae
allysin
a derivate of lysine; component of elastin and collagen
amputation
removal of a body part
amyloidosis
accumulation of abnormal changed proteins in the interstitium
anagen stage
growth phase of the hair cycle
anastomosis
connection between two anatomic structures
angiogenesis
formation of new vascular structures, important repair process of wound healing
angiopathy
vascular disease; strictly speaking arterio-sclerotic changes of the arteries
antibiotic (pl. antibiotics)
drug for the treatment of bacterial caused infectous diseases
antigen („**Anti**body **gen**erating")
structures, to which antibodies may specifically bind
antimycotic (pl. antimycotics)
drug for the treatment of fungal diseases (mycosis)
apocrine
characteristic of exocrine glands to secrete also parts of the cytoplasm during secretion
apoptosis
programmed cell death
arteriosclerosis
arterial calcification; systemic disease of the arteries, which leads to deposits of blood lipids, thrombogenesis, connective tissue in the vessel walls
assessment
evaluation, estimation, appraisal
asymptomatic
without symptomes/signs of illness
atrophy blanche
visible results of vessel diseases, seen on the skin; small-area white spots of often course, scarred texture

bactericidal
bacteria killing
bacteriostatic
impeding bacterial growth
basal lamina
multilayered, extracellular structure between epithelial tissue and connective tissue; dermo-epidermal junction
B cell
forms antibodies after contact to an antigen; it is part of the adaptive immune system

calcification
calcareus deposits in tissues
capillares
smallest blood vessels
caryoplasma
nucleoplasma
catagen phase
transitional phase of the hair
cell adhesion molekules
proteins, that mediate cell contacts
cell chromatine
total of chromosomal material of a cell, consisting of DNA, proteines and RNA
cell connections
see cell junctions
cell junctions
cell connections, direct point of contact of cells
cell membrane
double membrane, consisting of a lipid bilayer with a thickness of approx. 6-10 nm
cell migration
active changes of place of cells or cell complexes
cell nucleus membrane
double membrane, consisting of a lipid bilayer with a thickness of approx. 35 nm
cell organelles
functional units of a cell
cell plasma
see cytoplasma
centrioles
cell organelles, cylindrical structures, are found always pairwise and assume transport and support jobs
Charcot´s foot
disease of the foot, particular in diabetes patients; named after the neurologist Jean-Martin Charcot; syn. neuroarthro-pathy
chemokine
(=**chemo**tactic cyto**kine**), signal proteines, initiate migration in cells
chemotaxis
impact on the moving direction of cells, caused by substance concentration gradients
cholecystectomy
gall bladder resection
cholesterol
important component of the plasma membrane
chondrocyte
cartilage cell
chondroitin sulfate
mucopolysaccharide, belongs to glyco-saminoglycans

chromatin
a complex consisting of DNA and special proteins
chromosome
macromolecule complex, that contains genes; is composed of DNA, which is packed with many proteins
claudicatio intermittens
syn. display window disease, short-time limping; because of circulatory disturbances it comes after short physical activity to pain, caused by lack of oxygen; the patients often pause before display windows, until the pain stops
clavus
"corn", callus formation with a spur that is pointing downwards
coagulation
clotting (of blood or lymph)
collagen
structural protein of the connective tissue
colonisation
setting up by micro organisms
compression
exertion of pressure on a tissue
congenital
innate
connexines
trans-membrane proteins, allow the direct interchange of molecules between adjacent cells
contamination
impurity of an object
contraction
abridgement
contracture
impairment of function and movement by shortening of cords, muscles, bands
corneocytes
devitalised and horny keratinocytes
corona phlebatica paraplantaris
varicous vein circle, sign of chronic venous insufficiency (CVI)
cortex
fibre layer, fibre strain; ceratin fibre bundle in hair
corticoides
steroid hormones
cuticula
cuticle layer, outer cortex layer of the hair
cutis
skin
cytokines
proteins, that regulate the growing and differenciation of cells
cytoplasma
term for cytosol and cytoskeletton of a cell
cytoplasmatic organelles
organelles in the cytoplasma of a cell
cytoskeleton
cell skeleton, a web in cells made of proteines
cytosol
liquid component of the cytoplasma
cytotoxic
cell toxic, cell damaging

debridement
removal of necrotic tissue, debris and coatings out of wounds
debris
devitalised organic tissue
decubitus
syn. decubitus ulcer, bedsore
deformation
abnormity/distortion caused by external influences
dementia
lost of already got cogitation
dentritic cells
cells of the immune system
dermatan sulphate
mucopolysaccharide, belongs to glykosaminoglykanes
dermatoliposklerosis
hardening of the subcutanous connective tissue
dermatophytes
filamentous fungi, which cause a fungal infection of the skin (dermatophytosis); dermatophytes nourish on carbohydrates and keratin
dermis
cutis, true skin, the middle of the three skin layers
desmosine
amino acid, component of the fibrous protein elastin
desmosomes
cell structures in cell membranes, that care for a close connection between two cells; improve the mechanical cohesion
detritus
organic debris
devitalised
not living, dead (e.g. tissue)
diploid
presence of a double chromosome set (genetics)
dissemination
distribution of pathogens in an organ
Doppler sonography
ultrasound examination, for measuring the flow speed of blood in vessels

eccrine
characteristic of exocrine glands to secrete without lost of cytoplasm or parts of the cell
elastin
fibrous protein for shaping and stability, gives the skin elasticity
eleidin
intracellular protein in the stratum lucidum of the skin
elephantiasis
extreme increase of a body-part because of lymphostasis; mostly on legs or genitals
endoplasmatic reticulum (abbr. ER)
membrane web of eukaryotic cells, consisting of tubes, vesicles and cisterns
endothelial cells
cells of the innermost wall layer of lymphatic and blood vessels
endotoxines
decomposition products (parts of the cell membrane) of gram-negative bacteria and cyanobacteria
enzymatic
effected by enzymes; only under participation of enzymes proceeding metabolic reactions
enzyme
biochemic catalyser, accelerates biochemic reactions
epidermis
scarf skin, outermost layer of the skin
epithelial tissue
name for surface and glandular tissue; single- or multi-layered cell layers
epithelisation phase
reparation phase, immigration of epithelial cells
eponychium
epithelial tissue that lies in the nail pocket dorsal to the nail plate
erythema
skin reddening
eukaryotics
organisms, which cells have got a nucleus
exudate
excretions, mostly due to inflammations
exudation phase
syn. cleansing phase or inflammation phase; foreign particles and germs are poured out of the wound
extracorporal
outside of the body

fascias
soft-tissue components of the connective tissue; collagenous connective tissue
fibrils
small, thin fibres
fibrin
important protein for blood coagulation
fibrinolysis
syn. dissolution of fibrin; autologous dissolution of blood clots
fibroblast
cell of the connective tissue, which mainly produces collagen
fibrocytes
immobile cells of the connective tissue, they connect cells together and stabilise the connective tissue
fibronectin
glykoprotein of the extracellular matrix
filament
fibrous cell structure
follicle
hair sac
friction
rubbing

gangrene
tissue necrosis
gap junctions
cell connections, that connect the cytoplasma of adjacent cells together
gelatinase
proteolytic enzyme, belongs to matrix-metalloproteases (MMP)
gene
section on the DNA, contains genetic information
glycine
non-essential amino acid, important part of most proteines
glycokalyx
layer on the outer side of a cell membrane of eukaryotic cells
glycolipids
mono- or oligosaccharides, glycosidic bound to a lipid-molecule, i.a. part of the cell membrane
glycolysis
degradation of monosaccharides, part of the glucose metabolism, takes place in the cytoplasma of the cell
glycoproteines
macro-molecules, consisting of a proteine and one or more carbohydrate groups, i.a. component of the cell membrane
glycosaminoglycan (GAG)
mucopolysaccharide, carbohydrate side chains of the high molecular proteo-glykanes
golgi apparatus
part of eukaryotic cells, near the nucleus
granulation phase
syn. proliferation phase, refill of the wound defect with connective tissue
granulation tissue
form of the connective tissue during wound healing
granulocyt
belongs to the white blood cells (leukocytes); for non-specific pathogen control

haematoma
effusion, black and blue mark
haematpoesis
blood formation
haemostasis
stopping bleeding; physiologic process in three steps, leads to the stop of bleeding
hallux valgus
tilted position of the big toe
hemidesmosomes
adhering complexes, that make the connection between epithelial cells and the basal membrane
heparin sulphate
mucopolysaccharide, belongs to the glycosaminoglycanes
heterotopic
occuring or developing on atypic positions
histiocyte
makrophage of the tissue; sessile form of a makrophage
hyaluronic acid
mucopolysaccharide, belongs to the glycosaminoglycanes
hydrocolloides
polysaccharides and proteines, which dissolve in water as colloides and show a high ability of gelation
hydrofiber
sodium carboxy methylcellulose, forms a dimensionally stable gel in contact with exudate
hydrogel
gel on the base of polymeres that contains water, which molecules are connected to a three-dimensional network
hydrolysis
splitting of a chemical compound by a reaction with water
hydroxyproline
amino acid, that occur, chemical bound, in the collagene of the connective tissue

hydroxyurea
has a cytostatic effect, inhibits ribonuclein reductasis
hyperaemia
excessive blood in the tissue, mostly caused by dilatation of vessels
hypertension
syn. hypertonia, high blood pressure
hypoalbuminaemia
reduced concentration of albumine in the blood plasma
hypomotility
reduced physical activity
hyponychium
nail bed

immunosuppression
suppression of the immune system
incidence
number of new diseases in a certain period
infection, systemic
pathogenes spread over the whole organic system or the whole organism
inflammation phase
see exudation phase
innexines
protein family, implicated in the construction of the cell-cell-channels of the gap junctions
insufficiency
limited in functional and efficiency capability
interdigital
between fingers and toes
intermediary filaments
proteins of the cytoskeleton of eukaryotic cells
intertrigo
red, itchy and weeping skin defects in skin folds, caused by friction
ischaemia
insufficient blood supply

keratan sulphate
mucopolysaccharide, belong to glycosaminoglycanes
keratin
fibrous protein, main component of hair and nails
keratinocytes
keratin forming cells
keratohyalin
accumulates during keratinisation in the stratum granulosum and the stratum spinosum in form of small granulas inside the cells

lamin
protein of the cytoskeleton of eukaryotic cells
Langerhans cells
cells of the immune system
lesion
impairment, injury
leucocytes
white blood cells, white blood corpuscles
lipase
enzyme, that splits fat (lipides) into glycerine and free fatty acids
lipid
colloquial "fat"; lipids can be subdivided in fatty acids, triacylglycerides, waxes, phospholipides, sphingolipides, lipopoly-saccharides and isoprenoides
lipid bilayer
part of the cell membrane, consisting of lipides with hydrophile and hydrophobe fractions; nearly impervious for polar molecules or macro molecules
lipoprotein membrane
cell membrane, consisting of lipides and proteins
lunula
"nail moon"; area in which the substance of the nail plate is formed
lymphocyte
part of the adaptive immune system
lysin
an amino acid
lysyl oxidase
enzyme, mainly in the extracellular space of the connective tissue
lysosome
cell organelle for intracellular digestion

macroangiopathy
arteriosclerotic transformation of the greater arteries
macrophage
phagocyte, removes microorganisms by phagocytosis
malum perforans
ulcer of the foot sole, often in diabetics as a consequence of polyneuropathy
mast cell
see mastocyte
mastocyte
mast cell, autologous killer cell
matrix, extracellular
tissue between cells
maturation phase
remodelling, scar formation
medulla
medullary canal of the hair
melanocytes
pigment cells of the skin
membrane lipids
lipid components of cell membranes
membrane proteines
protein components of cell membranes
membrane tubuli
part of the endoplasmic reticulum
Merkel cells
sensory cells of the dermis; mechano-receptors of the tactile perception
mesenchyme
embryonal connective tissue
metallo-proteinases
zinc-containing proteolytic enzymes
microangiopathy
arteriosclerotic transformation of the smaller arteries
microbe
micro organism
micro organism
smallest organism
micro tubuli
parts of the cytoskeleton of eukaryotic cells
mitochondria
cell organelles of eukaryotic cells, so-called "power plant" of a cell
mitogen
cell division stimulating
monocyte
autologous antibody cell, that circulates in the blood
monofilament fibres
fibre consisting of single-thread yarn
morphogenesis
development of an organ or tissue
motility
ability for moving
mRNA
messenger RNA, template of the protein biosynthesis
muscular atrophy
muscle loss
myofibroblasts
cells of the connective tissue, which produce mainly collagen

necrophage
organism, that feeds on devitalised tissue
necrosectomy
removing devitalised tissue
necrosis
devitalised tissue
nephropathy
disease of the kidneys
neuroarthropathy
syn. neuroosteoarthropathy; final stage of diabetic foot syndrome, angiopathy and neuropathy lead to malnutrition of the bones and finally to its destruction
neuropathy
disease of the peripheral nervous system
nuclear lamina (lamina fibrosa nuclei)
protein layer on the inner side of the nuclear membrane
nuclear membrane
shell of the cell nucleus
nuclear pores
channels in the nuclear membrane of eukaryotic cells; allows the transportation of certain molecules in and out of the cell nucleus
nuclease
enzyme for the degradation of nucleine acids
nucleus
cell kernel

oedema
tissue swelling because of fluid retention
onychisation
nail formation
ossification
formation of bone
osteomyelitis
inflammation of the bone marrow

palliative
(pain) alleviating
PAOD
peripheral arterial occlusive diseas; disturbance of the arterial blood circulation of the lower extremities
paraplegia
section palsy
pathologic(al)
morbid, abnormal

perinuclear cistern, perinuclear area
gap space between inner and outer cell membrane
perionychium
nail fold
periosteum
bone skin
permeability
perviousness
peroxinitrite
reactive conjunction, results of nitrogen-monoxid- and nitrogen-superoxid radicales
peroxisomes
cell organelles of eukaryotic cells with metabolic function
phagocytosis
absorption of particles or molecules by a cell
phenotype
appearance (genetics)
phospholipid
phosphorous, amphiphilic lipid, main component of cell membranes
phosphoric acid
acid of phosphor, anorganic acid
phosphorylation
attaching a phosphate group to an organic molecule
physiology
nature study, branch of biology
adj. physiologic = natural
pinocytosis
absorption of liquids by a cell
plasma cell
cell of the immune system, that produces antibodies
plasma membrane
see cell membrane
plexus
mesh (consisting of nerve fibres or blood vessels)
polyneuropathy
disease of the peripheral nerve system, which affects several nerves
polyurethane
versatile synthetic material
postoperative
after a surgical intervention
preoperative
before a surgical intervention
prevalence
frequency of illness
prevention (of diseases)
to preserve or promote the healt of persons
proinflammatory
promoting an inflammation
prokaryotes
organisms that have cells without demarcated nucleus (bacteria and archaea)
proliferation
growth and reproduction (of cells)
prolin
amino acid
prophylaxis
measure, to prevent an impairment of health by illness
protease
protein splitting enzyme
protease inhibitor
molecule, that inhibits proteases
protein
macro molekule, consisting of amino acids, that are connected by peptide bondes
protein biosynthesis
new formation of proteins in cells
proteoglykan
component of the extracellular matrix
proteolysis
enzymatic hydrolysis of proteines

recurrence
reappearance of a disease, relapse
reepithelisation
covering of skin defects with new epithelial tissue
remodeling
scarring, cicatrisation
resection
surgical removal of organs/tissue or parts of it
reticulin
collagene fibres
retinopathy
disease of the retina
retraction
contraction of tissue/organs
rhagade
deep fissure, that tears through all layers of the epidermis
ribosomes
macromolecular complexes, consisting of proteines and ribonucleinacids (RNA)
rRNA
ribosomal RNA
rupture
fissure, disruption

Schwann cell
part of the myelin sheath in the peripheral nerve system
sclerosis
hardening of organs or tissue
sebocytes
tallow cells
sebum
skin tallow
secretion
exudation of endogenous substances, esp. from glands resp. gland-like cells
secretory vesicle
transportation vesicle of the Golgi apparatus
semipermeable
half pervious
senescence
old age
sepsis
systemic inflammatory reaction after infection by bacteria, its toxines or fungi ("blood poisoning")
septum, pl. septa
partition wall, that demarcates two tissues from one another or divides a body cavity in two parts
serous
consisting of blood serum
shave-excision
horizontal excision, horizontal removal of elevated skin changes
splenectomy
surgical removal of the spleen

stratum basale
basal cell layer, an epidermal skin layer
stratum corneum
horny cell layer, an epidermal skin layer
stratum granulosum
corn cell layer, an epidermal skin layer
stratum lucidum
shiny layer, an epidermal skin layer
stratum papillare
papillary layer, an dermal skin layer
stratum reticulare
reticular layer, an dermal skin layer
stratum spinosum
spinous layer, an epidermal skin layer
stromelysin
matrix-metalloproteinase (MMP)
subcutis
hypoderm
subungual
underneath a nail
superabsorber
synthetic material, that may absorb a multiple of its own weight of liquids (e.g. exudate)
surface antigen
antigenes (=antibodies generating substances) on cell surfaces
symptomatic
symptom-related
synthesis
connection of two or more parts to a new
unit
systemic
concerning the whole organism

telogen phase
resting phase of the hair
tenascin
glycoprotein of the skin
terminal stage
last phase of life of people with a disease that leads to death
tetraplegia
palsy of all four extremities
thoracotomy
surgical opening of the thorax
thrombocytes
blood platelets
T-lymphocyte
forms antobodies after contact to antigenes; is part of the adaptive immune system
translation
synthesis of proteines in cells, by means of the copied genetic information
tubulin
cell protein, main component of micro-tubuli

ulcus cruris
leg ulcer
ulceration
development of an ulcer
undermining
opening, that leads from the wound ground as far as under the skin
adj. undermined
unguis incarnatus
ingrown nail, mostly on the big toe

valin
essential amino acid
vasculitis
vascular inflammation
vasoconstriction
narrowing of the blood vessels
vasodilatation
widening of the blood vessels
Vater Pacini corpuscles
mechanoreceptors of the skin
vegetative
not being subject to the will
vesicles
intracellular small bubbles
vital
alive, healthy and lively
vitronectin
protein of the extracellular matrix, conduces cell adhesion
wound(bed)conditioning
exertion of granulation promoting stimuli to the wound

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Product List (Excerpt)

○ = LIGASANO® white
● = LIGASANO® orange
● = LIGASANO® green

LIGASANO® Wound cleaning sponges for wound cleaning and mechanical debridement

Item no.	UDI-DI	Shipping unit	
16814-010	111725184144	10 pcs. 5 x 5 x 2 cm green **sterile**	●
16814-015	111725185834	15 pcs. 5 x 5 x 2 cm green **sterile** **dispenser box**	●
16814-030	111725186400	30 pcs. 5 x 5 x 2 cm green **sterile**	●
16815-010	111725187063	10 pcs. 15 x 5 x 0.6 cm green **sterile**	●
36814-010	111725207110	10 pcs. 5 x 5 x 2 cm orange **sterile**	●
36814-015	111725208800	15 pcs. 5 x 5 x 2 cm orange **sterile** **dispenser box**	●
36814-030	111725209463	30 pcs. 5 x 5 x 2 cm orange **sterile**	●
15342-010	111725126110	10 pcs. 5 x 5 x 2 cm white **sterile**	○
15342-015	111725127800	15 pcs. 5 x 5 x 2 cm white **sterile** **dispenser box**	○
15342-030	111725128463	30 pcs. 5 x 5 x 2 cm white **sterile**	○
36815-005	111725212513	OP consisting of 5 peel pack each with 1 piece LIGASANO® green 5 x 5 x 2 cm **sterile** 1 piece LIGASANO® orange 5 x 5 x 2 cm **sterile** 1 piece LIGASANO® white 5 x 5 x 2 cm **sterile**	● ● ○
16812-010	111725182915	10 pcs. 30 x 1.5 x 0.6 cm green **sterile**	●
16812-028	111725183578	28 pcs. 30 x 1.5 x 0.6 cm green **sterile** **dispenser box**	●
36812-010	111725204288	10 pcs. 30 x 1.5 x 0.6 cm orange **sterile**	●
36812-028	111725205978	28 pcs. 30 x 1.5 x 0.6 cm orange **sterile** **dispenser box**	●
15372-010	111725154561	10 pcs. 50 x 1.5 x 0.4 cm white **sterile**	○
15372-028	111725155127	28 pcs. 50 x 1.5 x 0.4 cm white **sterile** **dispenser box**	○

Sterile Wound Dressings

Item no.	UDI-DI	Shipping unit	
15341-010	111725124978	10 pcs. 5 x 5 x 1 cm **sterile**	○
15341-040	111725125544	40 pcs. 5 x 5 x 1 cm **sterile** **dispenser box**	○
15342-010	111725126110	10 pcs. 5 x 5 x 2 cm **sterile**	○
15342-015	111725127800	15 pcs. 5 x 5 x 2 cm **sterile** **dispenser box**	○
15342-030	111725128463	30 pcs. 5 x 5 x 2 cm **sterile**	○
15346-010	111725129029	10 pcs. 10 x 10 x 1 cm **sterile**	○
15346-020	111725130947	20 pcs. 10 x 10 x 1 cm **sterile** **dispenser box**	○
15346-200	111725131513	200 pcs. 10 x 10 x 1 cm **sterile**	○
15347-010	111725132176	10 pcs. 10 x 10 x 2 cm **sterile** **dispenser box**	○
15350-015	111725133866	15 pcs. 15 x 10 x 0.5 cm **sterile**	○
15350-030	111725134432	30 pcs. 15 x 10 x 0.5 cm **sterile**	○
15351-010	111725135095	10 pcs. 15 x 10 x 1 cm **sterile**	○
15351-020	111725136785	20 pcs. 15 x 10 x 1 cm **sterile**	○
15351-140	111725137351	140 pcs. 15 x 10 x 1 cm **sterile**	○
15356-010	111725145673	10 pcs. 15 x 10 x 2 cm **sterile**	○

Continuation LIGASANO® white: sterile wound dressings and wound filler

Item no.	UDI-DI	Shipping unit	
15352-010	111725140401	10 pcs. 24 x 16 x 1 cm **sterile**	○
15352-070	111725141064	70 pcs. 24 x 16 x 1 cm **sterile**	○
15357-005	111725146239	5 pcs. 24 x 16 x 2 cm **sterile**	○
15360-010	111725147929	10 pcs. 29.5 x 24.5 x 1 cm **sterile**	○
15385-010	111725162883	10 pcs. Ø 5 cm x 1 cm round compress **sterile**	○
15385-040	111725163449	40 pcs. Ø 5 cm x 1 cm round compress, **dispenser box** **sterile**	○

Sterile Wound Strips / Cavity Dressings

Item no.	UDI-DI	Shipping unit	
15370-010	111725148592	10 pcs. 300 x 2.5 x 0.4 cm wound strip **sterile**	○
15371-007	111725151642	7 pcs. 100 x 1.5 x 0.4 cm wound strip mini **sterile**	○
15371-014	111725152208	14 pcs. 100 x 1.5 x 0.4 cm wound strip mini, **dispenser box** **sterile**	○
15371-028	111725153995	28 pcs. 100 x 1.5 x 0.4 cm wound strip mini **sterile**	○
15372-010	111725154561	10 pcs. 50 x 1.5 x 0.4 cm wound strip micro **sterile**	○
15372-028	111725155127	28 pcs. 50 x 1.5 x 0.4 cm wound strip micro, **dispenser box** **sterile**	○
15375-010	111725156817	10 pcs. 6 x 2.5 x 0.4 cm sticks **sterile**	○
15375-060	111725157480	60 pcs. 6 x 2.5 x 0.4 cm sticks **sterile**	○

Sterile Bandages and Mini Bandages

Item no.	UDI-DI	Shipping unit	
15378-030	111725158046	30 pcs. 30 x 5 x 0.3 cm mini bandage **sterile**	○
15379-030	111725159736	30 pcs. 50 x 5 x 0.3 cm mini bandage **sterile**	○
15381-008	111725160530	8 pcs. 300 x 5 x 0.3 cm bandage, width 5 cm **sterile**	○
15383-004	111725161193	4 pcs. 300 x 10 x 0.3 cm bandage, width 10 cm **sterile**	○

LIGASANO® green: Sterile Wound Dressings and Wound Filler for NPWT

Item no.	UDI-DI	Shipping unit	
16814-010	111725184144	10 pcs. 5 x 5 x 2 cm **sterile**	●
16814-015	111725185834	15 pcs. 5 x 5 x 2 cm **dispenser box** **sterile**	●
16814-030	111725186400	30 pcs. 5 x 5 x 2 cm **sterile**	●
16815-010	111725187063	10 pcs. 15 x 10 x 0,6 cm **sterile**	●
16816-010	111725188753	10 pcs. 15 x 10 x 1 cm **sterile**	●
16816-020	111725189319	20 pcs. 15 x 10 x 1 cm **sterile**	●
16817-010	111725191803	10 pcs. 15 x 10 x 2 cm **sterile**	●
16820-005	111725193032	5 pcs. 24 x 16 x 2 cm **sterile**	●
16820-035	111725194722	35 pcs. 24 x 16 x 2 cm **sterile**	●

LIGASANO® green: Sterile Wound Dressings and Wound Filler for NPWT

16812-010	111725182915	10 pcs. 30 x 1,5 x 0,6 cm **sterile** wound strip mini	●
16812-028	111725183578	28 pcs. 30 x 1,5 x 0,6 cm **sterile** wound strip mini, **dispenser box**	●
16865-010	111725199994	10 pcs. 200 x 2 x 0,6 cm **sterile** wound strip	●

LIGASANO® orange: Sterile Wound Dressings and Wound Filler for NPWT

Item no.	PZN	Shipping unit	
36814-010	111725207110	10 pcs. 5 x 5 x 2 cm **sterile**	●
36814-015	111725208800	15 pcs. 5 x 5 x 2 cm **sterile** **dispenser box**	●
36814-030	111725209463	30 pcs. 5 x 5 x 2 cm **sterile**	●
36817-010	111725213176	10 pcs. 15 x 10 x 2 cm **sterile**	●
36820-005	111725214866	5 pcs. 24 x 16 x 2 cm **sterile**	●
36812-010	111725204288	10 pcs. 30 x 1.5 x 0.6 cm **sterile** wound strip mini	●
36812-028	111725205978	28 pcs. 30 x 1.5 x 0.6 cm **sterile** wound strip mini, **dispenser box**	●

Unsterile Dressing, Smaller Sizes

Item no.	UDI-DI	Shipping unit	
15151-010	111725106078	10 pcs. 15 x 15 x 1 cm unsterile	○
15152-010	111725107768	10 pcs. 24 x 16 x 1 cm unsterile	○
15153-005	111725108334	5 pcs. 24 x 16 x 2 cm unsterile	○
15158-013	111725110818	13 pcs. 15 x 10 x 2 cm unsterile	○
15008-104	111725083015	104 pcs. 15 x 10 x 2 cm unsterile sub-packed 8 x 13 pcs.	○
15159-026	111725111481	26 pcs. 15 x 10 x 1 cm unsterile	○
15009-208	111725084705	208 pcs. 15 x 10 x 1 cm unsterile sub-packed 8 x 26 pcs.	○

LIGASANO® white: Unsterile Dressings for Concomitant Wound Treatment, Large Sheets

Item no.	UDI-DI	Shipping unit	
12001-002	111725062320	2 pcs. 59 x 49 x 2 cm unsterile	○
12001-007	111725064673	7 pcs. 59 x 49 x 2 cm unsterile	○
12001-028	111725065239	28 pcs. 59 x 49 x 2 cm unsterile	○
12002-004	111725066929	4 pcs. 59 x 49 x 1 cm unsterile	○
12002-014	111725067592	14 pcs. 59 x 49 x 1 cm unsterile	○
12002-056	111725068158	56 pcs. 59 x 49 x 1 cm unsterile	○
12003-025	111725069848	25 pcs. 59 x 49 x 0.5 cm unsterile	○
12003-100	111725070642	100 pcs. 59 x 49 x 0.5 cm unsterile	○
12006-001	111725071208	1 pcs. 200 x 100 x 2 cm unsterile	○
12007-002	111725072995	2 pcs. 200 x 100 x 1 cm unsterile	○
13004-005	111725075817	5 pcs. 59 x 98 x 2 cm unsterile	○
13004-020	111725077046	20 pcs. 59 x 98 x 2 cm unsterile	○
13005-010	111725078736	10 pcs. 59 x 98 x 1 cm unsterile	○
13005-040	111725079302	40 pcs. 59 x 98 x 1 cm unsterile	○

Unsterile Bandages

Item no.	UDI-DI	Shipping unit	
15571-012	111725171771	12 pcs. 300 x 5 x 0.3 cm unsterile	○
15573-006	111725174690	6 pcs. 300 x 10 x 0.3 cm unsterile	○

LIGASANO® white: unsterile dressing for special applications

Art. no.		Shipping unit	
15070-012	111725094256	12 pcs. 6 x 3.5/2.5/1.5 x 0.5 cm unsterile tube for toes	○
15075-002	111725095946	2 pcs. Ø 4.5/4.0 x 12 cm unsterile hallux valgus dressing	○
15075-006	111725096512	6 pcs. Ø 4.5/4.0 x 12 cm unsterile hallux valgus dressing	○
15075-024	111725097175	24 pcs. Ø 4.5/4.0 x 12 cm unsterile hallux valgus dressing	○
15078-012	111725098865	12 pcs. Ø 2.5 x 12 cm unsterile dressing for hammer toes	○
15083-025	111725099431	25 pcs. Ø 3.5 cm x 1 cm unsterile	○
15085-036	111725100240	36 pcs. Ø 5 cm x 1 cm unsterile	○
19100-002	111725200706	2 pcs. Ø 15 cm x 8/5 cm unsterile	○
19100-024	111725201369	24 pcs. Ø 15 cm x 8/5 cm unsterile	○

LIGASANO® *Roll* Dispenser Boxes

without adhesive edge

Item no.	UDI-DI	Shipping unit	
15025-001	111725085368	1 pcs. 200 x 2.5 x 1 cm unsterile	○
15225-001	111725120369	1 pcs. 300 x 2.5 x 0.6 cm unsterile	○
15050-001	111725088287	1 pcs. 300 x 5.0 x 0.3 cm unsterile	○
15055-001	111725089977	1 pcs. 200 x 5.5 x 1 cm unsterile	○
15255-001	111725122625	1 pcs. 300 x 5.5 x 0.6 cm unsterile	○
15110-001	111725105415	1 pcs. 200 x 11 x 1 cm unsterile	○
15210-001	111725117222	1 pcs. 300 x 11 x 0.6 cm unsterile	○
16110-001	111725180659	1 pcs. 200 x 11 x 1 cm unsterile	○

with adhesive edge

15215-001	111725118912	1 pcs. 200 x 14 x 0.5 cm unsterile	○
15216-001	111725119575	1 pcs. 200 x 4,5 x 0.4 cm unsterile	○

LIGASANO® Compresses with Slit

Item no.	UDI-DI	Shipping unit	
15164-020	111725112047	20 pcs. 5 x 5 x 1 cm **sterile**	○
15165-020	111725113737	20 pcs. 7.5 x 7.5 x 1 cm **sterile** **dispenser box**	○
15166-020	111725116656	20 pcs. 10 x 10 x 1 cm **sterile** **dispenser box**	○
15063-020	111725090771	20 pcs. 5 x 5 x 1 cm unsterile	○
15064-020	111725091337	20 pcs. 7.5 x 7.5 x 1 cm unsterile	○
15065-020	111725093690	20 pcs. 10 x 10 x 1 cm unsterile	○

Item no.	UDI-DI	Shipping unit	
16001-002	111725175256	2 pcs. 55 x 45 x 2 cm unsterile	●
16001-007	111725176946	7 pcs. 55 x 45 x 2 cm unsterile	●
16001-028	111725177512	28 pcs. 55 x 45 x 2 cm unsterile	●
16006-001	111725178175	1 pcs. 190 x 90 x 2 cm unsterile	●
16008-006	111725179865	6 pcs. 190 x 45 x 2 cm unsterile operating-table-paddings, single packed	●
16210-002	111725181225	2 pcs. 49 x 49 x 9/1 cm unsterile	●

Palm Dressing

Item no.	UDI-DI	Shipping unit	
15090-012	111725101930	10 pcs. 29 x 12 x 1 cm unsterile palm dressing made of LIGASANO® white	○
		2 pcs. 10 cm width, ø 8 cm unsterile spiral rolls made of LIGASANO® green	●
15091-010	111725102593	10 pcs. 29 x 12 x 1 cm unsterile palm dressing made of LIGASANO® white	○

Plantar Dressing for Diabetic Feet

Item no.	UDI-DI	Shipping unit	
15098-007	111725103159	4 pcs. 35 x 15 x 1 cm unsterile	○
		1 piece 35 x 15 x 2 cm unsterile	○
		1 piece 35 x 15 x 2 cm unsterile	●
		1 piece stocking for fixation	
15099-020	111725104849	20 pcs. 35 x 15 x 1 cm unsterile later purchase package	○

Dressing for Fingers and Toes

Item no	UDI-DI	Shipping unit	
15215-001	111725118912	1 piece 200 x 14 x 0.5 cm unsterile rolled, can cut to fit, with adhesive stripe, for ca. 40-50 tubes for toes	○

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Sterile Tubes + Caps for Toes

Item no.	UDI-DI	Shipping unit	
15391-012	111725164015	12 pcs. 3.5/2.5 x 6 cm **sterile**	○
15392-012	111725165705	12 pcs. 2.5/1.5 x 6 cm **sterile**	○
15393-012	111725166368	12 pcs. 1.5 x 6 cm **sterile**	○
15394-015	111725169287	15 pcs. 14 x 10 x 0.5 cm **sterile** T-shape dressing for toes, with adhesive stripe for toe diameter from 1.0 to 3.8 cm	○

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Sterile Dressing for Hallux valgus

Item no.	UDI-DI	Shipping unit	
15395-004	111725170081	4 pcs. Ø 4.5/4.0 x 12 cm **sterile**	○

LIGASANO® white Spiral Dressings

Item no.	UDI-DI	Shipping unit	
15217-010	18044765	10 pcs. LIGASANO® white unsterile spiral dressing, Ø 1.6 cm, length 12 cm	○
15218-009	18044759	9 pcs. LIGASANO® white unsterile spiral dressing, Ø 2.5 cm, length 12 cm	○

LIGASANO® white Ear Dressing, unsterile

Item no.	UDI-DI	Shipping unit	
15072-018	111752685771	18 pcs. 20 x 10 x 1 cm unsterile ear dressing with punched opening for the ear, for folding	○

Omega Upholstery Dressing

Item no.	UDI-DI	Shipping unit	
36050-006	111725203625	1 piece LIGASANO® orange unsterile Omega pillow, adjustable in 5 heights	●
		5 pcs. LIGASANO® white unsterile skin contact dressing 15 x 10 x 1 cm	○

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Trapeze Upholstery Dressing

Item no.	UDI-DI	Shipping unit	
36060-006	111767494909	1 piece LIGASANO® orange unsterile Trapeze pillow, adjustable in 4 heights	●
		5 pcs. LIGASANO® white unsterile skin contact dressing 30 x 12 x 1 cm	○

Distribution / Supply

In Germany you can get our products in pharmacies or in medical specialist shops (medical healthcare supplies). Resellers may purchase LIGASANO® also directly at wholesale. If an article ought to be not in stock at the wholesale, you can buy it directly from us. We send it free of shipping costs and the ordered article is delivered in most cases the next day or the day after next at the latest.

You can reach us personally Monday to Thursday from 8.00 to 16.00 and Friday from 8.00 to 12.00. Outside business hours please tape us your message on the answerphone or send us an e-mail. For orders please use our email address **order@ligasano.com**.
Of course we deliver worldwide. We tell you the corresponding transportation cost on request. Because it varies according to size, weight and country we can inform you about the real cost not until your concrete order or request.

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