
Movement is Life Life is Movement

lecture by:

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Physiological Facts and Hints on the Subject Pressure Sore Lack of Movement Being the Cause of Pressure Ulcers - Decubitus

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Abstract

A decubitus ulcer develops out of a supply shortfall, a trophic disorder. A cellular layer, e.g. under the skin, is no more sufficiently supplied with blood and nutrients e. g. oxygen, if compression and shearing has disrupted the blood flow. The weight compresses the capillaries in the cell layer. If the perfusion is stopped for too long, a deficit of oxygen arises. The cells suffocate, break down, and poison their environment. The damage gets out of hand.

Any devices being applied to cure and prevent decubitus ulcers today, do now try to reduce the pressure that is being created by the weight: at the principle of soft bedding by enlarging the surface, at the principle of alternating pressure by intermittent free positioning.

The force generated by the weight certainly is the cause. However, we are familiar with this weight for millions of years and have learned to deal with it.

Weight shifting movements at regular intervals are performed always when standing, sitting, and lying to prevent supply shortfalls in the stressed tissue; and we, being healthy, do these movements, absolutely unwittingly, even when sleeping.

When this activity stops, due to sensor failures in the skin, a diabetic neuropathy, pain rigour etc., and the time- and target-oriented shifting of weight ceases, a cellular breakup is to come.

Overview:

- Cardiovascular system
- Blood flow in the capillaries
- Compression and shearing in the tissue
- Social aspects



Cardiovascular system

We do not have sufficient volume of blood to perfuse all our organs simultaneously. Therefore those organ systems not in use are only minimally perfused.

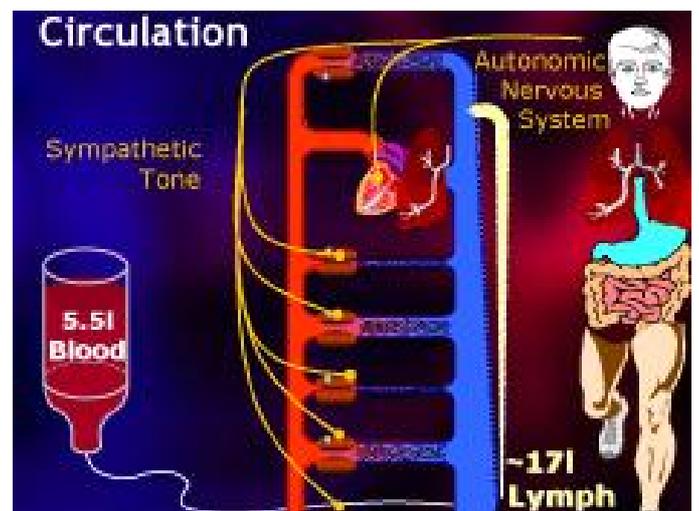
In preparation of activities e.g. body movements the central nervous system does increase the sympathetic tone (Central Command) within the autonomic nervous system.

This increase constricts the resistance vessels, speeds up the heart, thus raising the blood flow (Cardiac Output) in advance.

The sympathetic tone is all about the same for all resistance vessels. This increase of the tone increases the blood pressure, too, even before starting an activity.

Local messengers are breaking the constriction of the resistance vessels exactly at those locations that needs energy, thus directing the blood flow to tissues with an actual need. Nitrate monoxide (NO) is such a messenger. It is very fugacious and works very locally only.

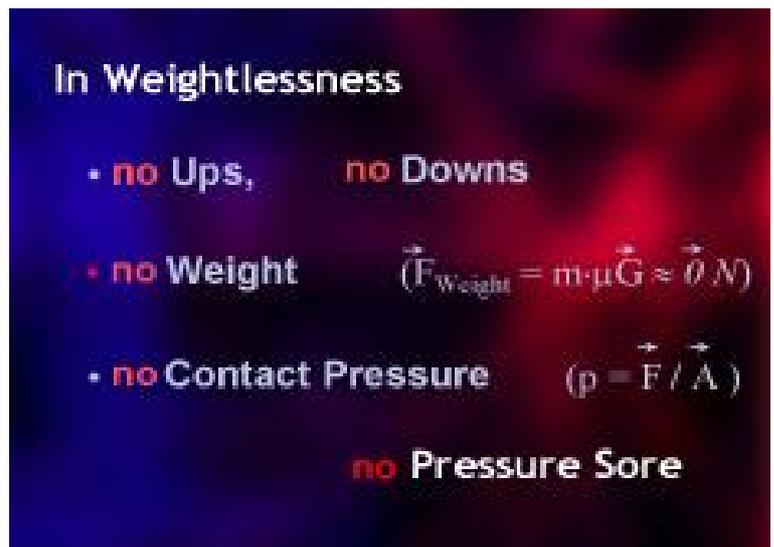
Shearing the vessels' inner wall e.g. by muscular contraction stimulates the production of NO. Under NO the resistance vessels relax at just those blood-supplying vessels requiring energy in the cell layer.



Reference to weightlessness

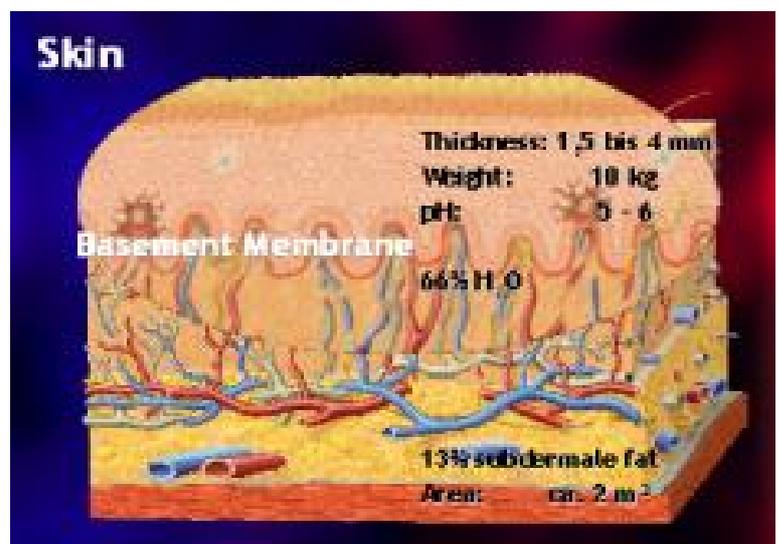
In weightlessness the factor gravity (G) comes close to zero (μG), and thus weight disappears (F_{Weight}). Hence it follows that no contact pressure (p) can develop.

This means that in weightlessness pressure ulcers cannot develop.



Skin

The skin is 1.5 to 4 mm thick and covers 2 m². As a whole it weighs approx. 10 kg. The pH value of the skin is 5 to 6, which ensures a certain degree of acid resistance. The basement membrane, reproducing new skin cells constantly, is covered by a protective layer of keratinising squamous epithelium. In this layer there are no blood vessels, which means that a damage inside or underneath the basement membrane does not appear immediately (decubitus grade I).



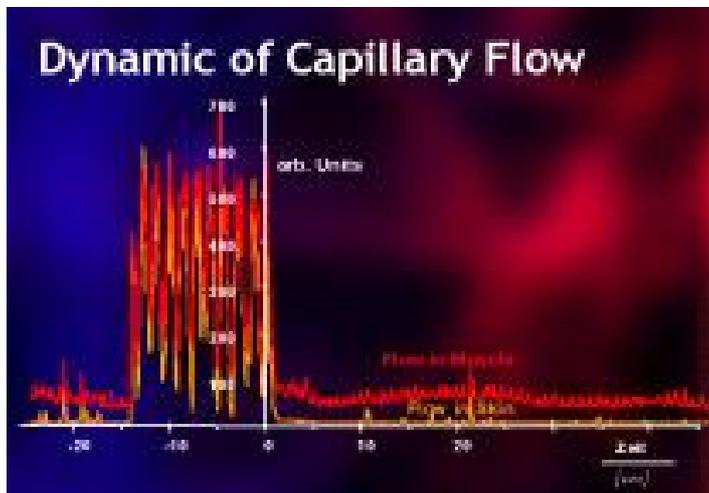
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Dynamics of the regional blood flow

The dynamic of the blood flow comprises more than two decimal forces (from less than 5 up to more than 500 cm/s), depending on trophic requirements (see fig. below).

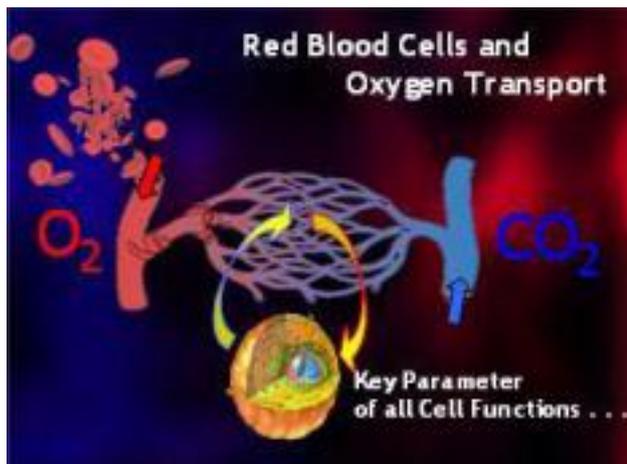
In comparison:

- pedestrian 5 km/h
- car within city limits 50 km/h
- small airplane 500 km/h



Blood supply is elementary dependent on movements; this applies for the muscles and the red blood cells in the capillaries.

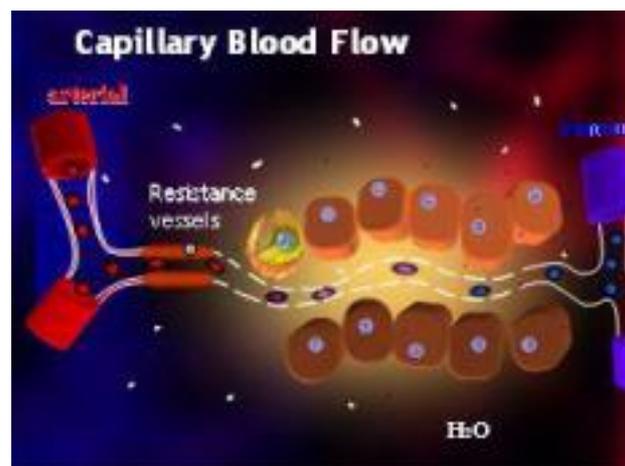
Capillary blood flow



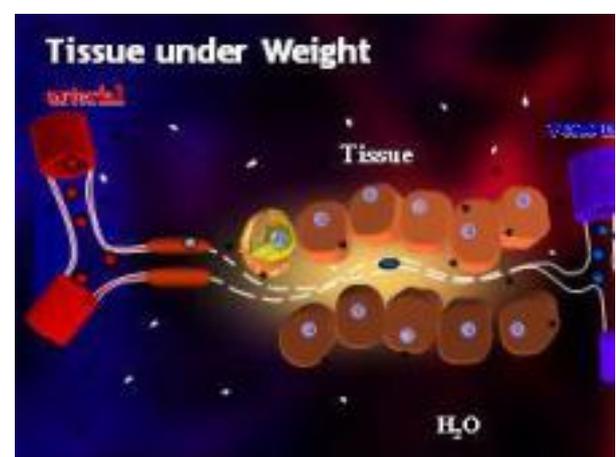
The red blood cells are vehicles for oxygen (O₂), since the watery solubility of oxygen is not sufficient for the amount of oxygen necessary for the functional integrity of cells.

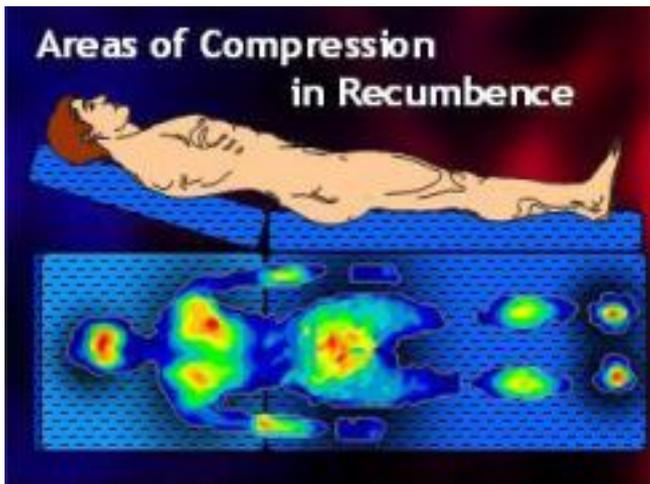
Also CO₂ is being removed via binding mechanisms at the haemoglobin.

If required, local messengers open the inflow and thus supply the active cells (e.g. muscles) with energy, just as required.



If weight compresses tissues, the capillary vessels do however collapse and the blood flow stops. If the perfusion is interrupted for too long, a deficit of oxygen arises. The cells suffocate, break down, and poison their environment. The damage gets out of hand.

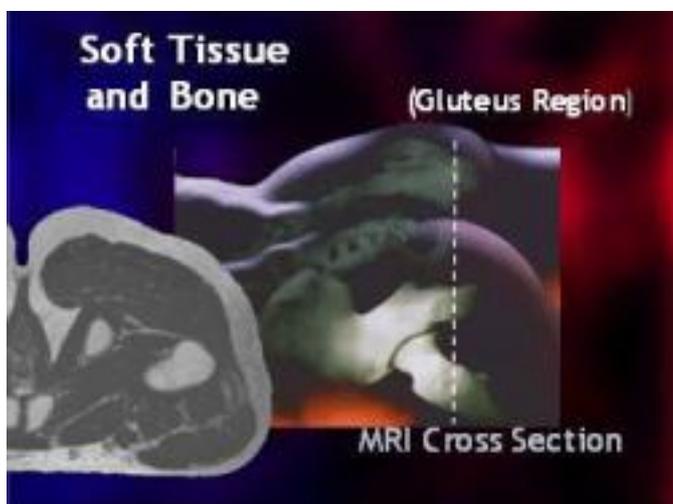
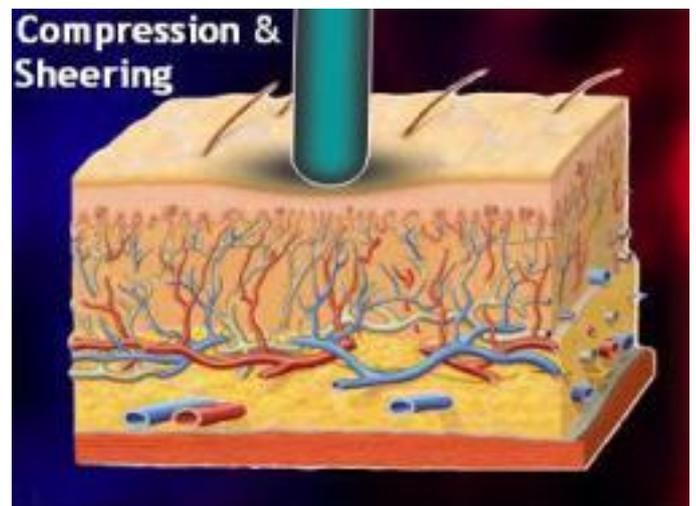




Decubitus ulcers are to be found at those skin areas where skin touches the surface and where an inner skeletal structure is on the direct opposite of these areas (e.g. back of the head, scapula, sacrum, ischium, and heel). However, a decubitus develops only, if the pressure is continuously persisting over a certain period of time. If this is the case, it results in a cellular breakdown and (cave!) also at the bony counter-part in the depth (decubitus grade IV).

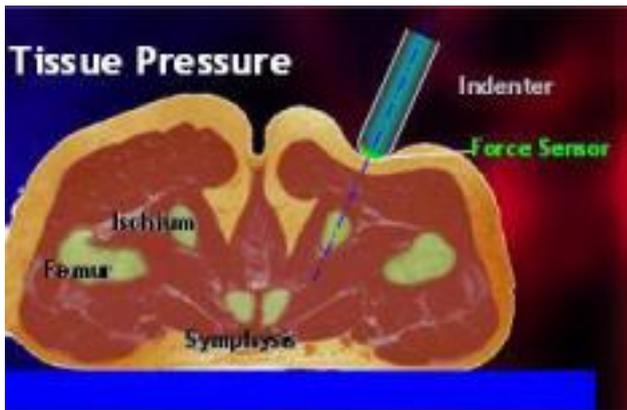
Compression and shearing does disrupt the blood flow.

The Flow behaviour in the capillary bed can be shown in an experiment.



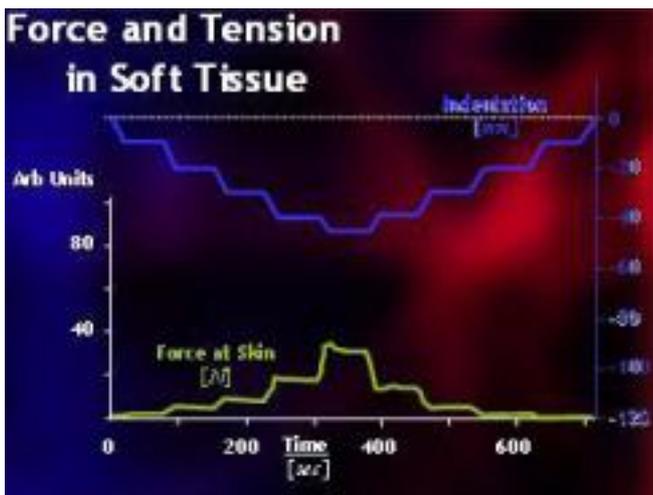
We applied controlled pressure to the tissue of an area, where pressure ulcers can be found most frequently.

An NMR graph shows the soft part components of the gluteal region and the bony counterparts (ischium) in cross-section.



Tissue pressure and capillary flow

Using an indenter the skin was being compressed gradually towards the ischium, recording indentation and force continuously.



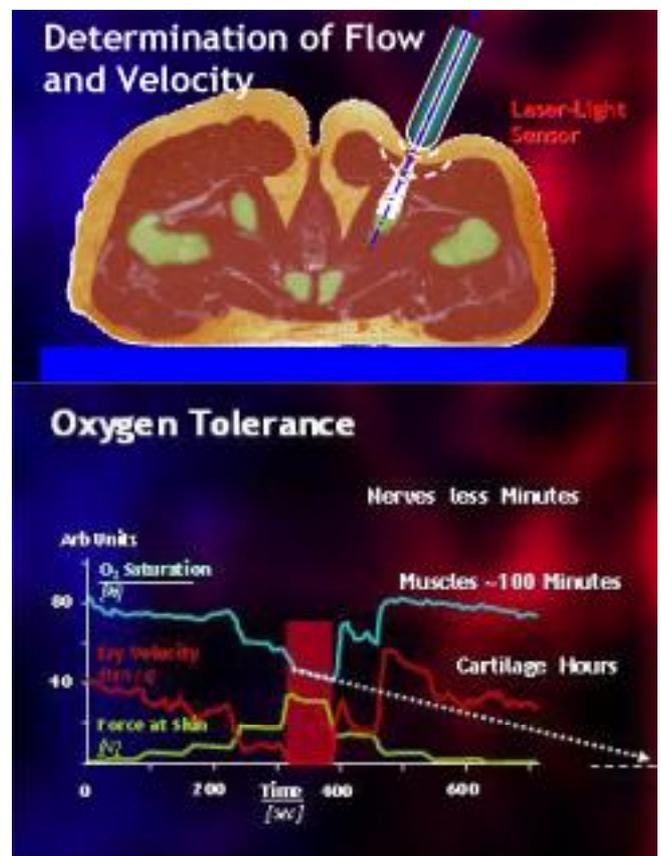
The force [N] (see figure left hand) on the skin grows with increasing deformation resp. indentation depth [mm]. When reducing the pressure it shows that the tissue has reacted plastically, as at an identical indentation depth less force is being measured at the surface of the indenter.

Flow rate

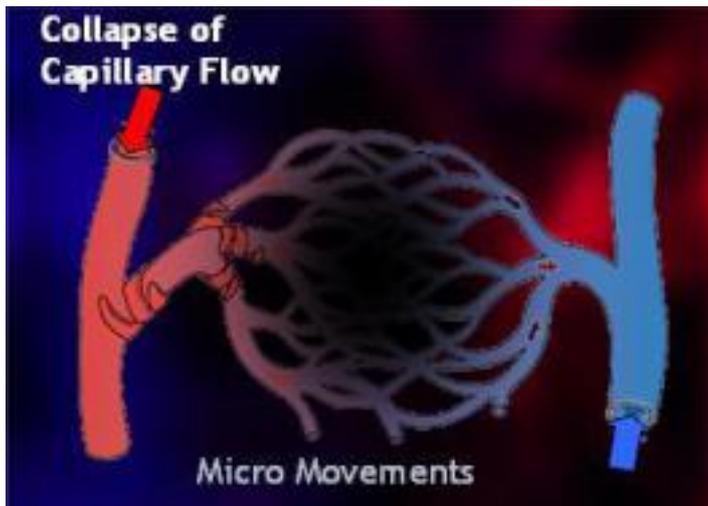
An additional sensor in the indenter measured both the speed and the oxygen saturation of the red blood cells simultaneously.

We compressed the tissue up to a level that the movements of red cells stopped. Oxygen then is still available in a certain amount by trapped red cells.

In this way load periods in tissues are being bridged. However, the tolerance periods are limited.



Body Movements

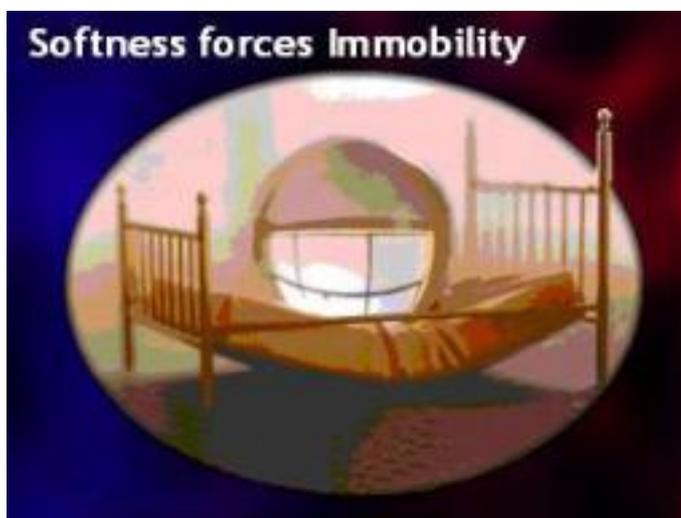
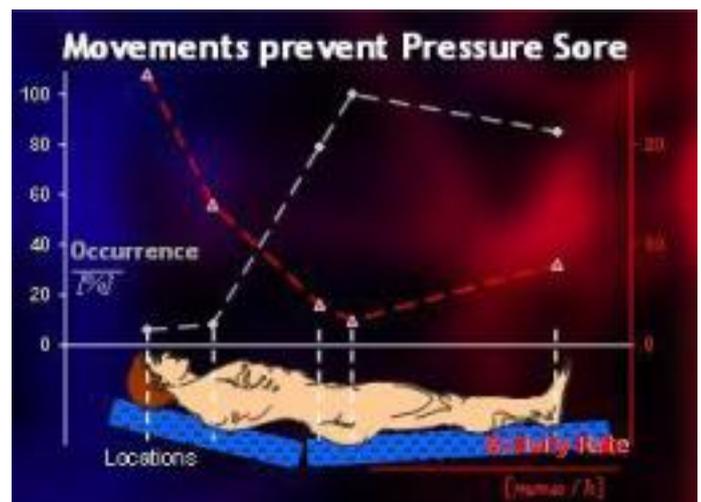


Constant movements, also micromotions, allow us to cope with the consequences of gravity.

In a constant change areas being compressed before are relieved again by shifting the weight.

This explains also why pressure ulcers are not that often found at the back of the head resp. the heel as are found in the gluteal region, although the higher contact pressure values are measured there.

Head and legs are being moved more often, even if suffering a serious disease.



If, due to the positioning on soft bed systems, mobility is restricted, this also implies an increasing risk to get a decubitus ulcer.

Devices

Any devices being applied to cure or prevent decubitus ulcers today, do now try to reduce the pressure that is being created by the weight: at the principle of soft bedding by enlarging the surface, at the principle of alternating pressure by intermittent free positioning.

The weight certainly is the cause of pressure ulcers. However, we are familiar with our weight for millions of years. We have learned to deal with it.

Weight shifting movements are always performed at regular intervals; naturally when we move by walking or running but also when we are standing, sitting, and lying. This weight shifting prevents a supply shortfall in the stressed tissue; and we, the healthy ones, do these movements, absolutely unwittingly, even when sleeping.

When this activity stops, e.g. due to sensor failures in the skin, a diabetic neuropathy, pain rigour etc., and the time- and target-oriented shifting of weight ceases, a cellular breakdown is to come.

Movement is indispensable to life; it is a vital feature: Life is movement.

This makes decubitus being a disease, since an elemental vital feature is damaged dramatically.

Nursing care, - in this case treatment care -, means that this breakdown needs to be compensated by regular change of position.

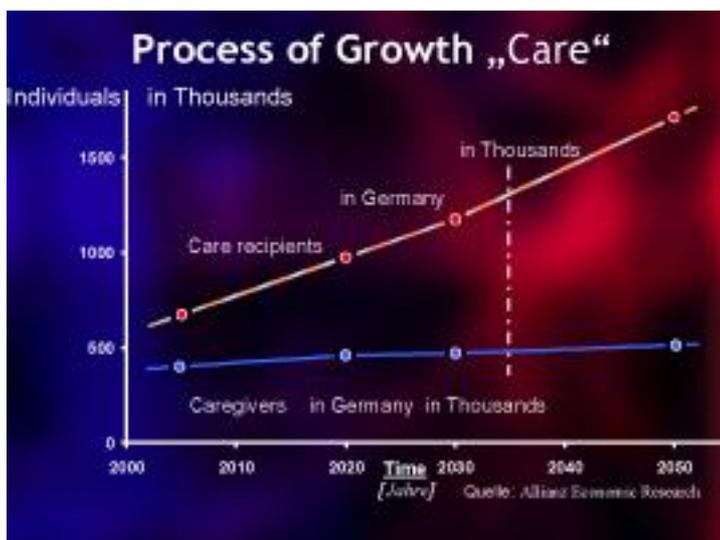
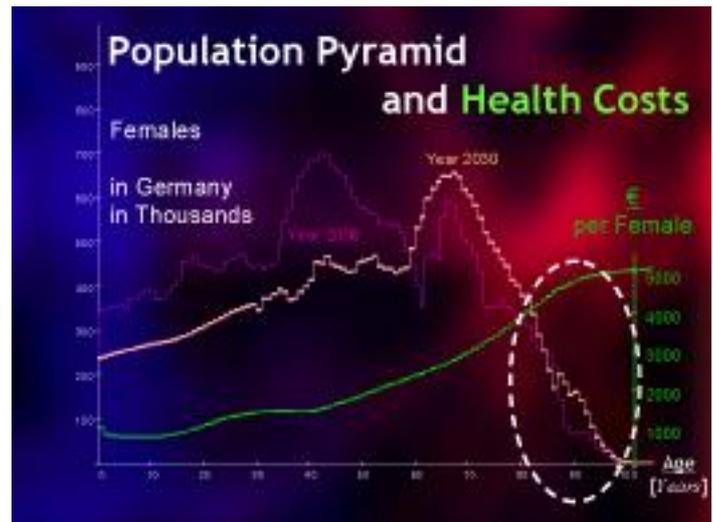
Thus, the treatment of pressure ulcer becomes a question of staff.

The nursing shortage is a (politically intended) supply shortfall in health care.

Social aspects

The update of the German population pyramid (see right hand for the female part) shows that the problem will get worse within the next 25 years. The share of the population having a high decubitus risk grows by more than 40%.

The insurance industry expects that this cannot be compensated by an adequate increase of the nursing staff.



But only the right combination of nursing care and technical tools can help to reduce the number of decubitus ulcer cases. It cannot be done without well-trained nursing staff and we should no longer tolerate the unprofessionalism in the organisation of nursing care!

Literature available at the author.

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Curriculum Vitae

Dr. Friedhelm Baisch

Born in 1948, married, three children. Degree in engineering and medicine, the last at the FU Berlin. Assistant physician at Clinic and Pre-Clinic Steglitz, today Campus Benjamin Franklin.

In 1981 change to the Institute of Aerospace Medicine at the DLR in Cologne Porz. Graduation at the University Cologne.

Primary Investigator (PI) during different space flight missions, both American and Russian ones.

Topic cardiovascular circulation regulation with focus on deconditioning of autonomic functions. Head of international studies; visiting researcher in Houston, Texas, and the Institute for Biomedical Problems (IBMP), Moscow.

Presently involved in the technological sector of the development of non-invasive medical diagnosis.