Keeping the intruders at bay – viral and bacterial infections acquired through skin and mucous membranes

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Infections can then develop when bacteria, fungi, viruses and Co. penetrate the skin barrier or the mucous membranes. Only after conquering these obstacles, the intruders can attack the internal structures of the body. What are the factors that facilitate or complicate the process, though? What can we do in our daily life to impede this process?

The human body has a sophisticated system to defend itself from microorganisms and virus attacks. The first obstacle is the horny layer, a physical protection that, as long as it is intact, only allows the passage of smaller molecules which, at best, can trigger allergies.
Also the mucous membranes of the **eye** (conjunctiva), the **nose** (including the lower respiratory tracts), the **mouth**, the **genital area**, and the **gastrointestinal tract** are rather hostile media for intruders. In addition to that, skin and mucous membranes are covered with a flora consisting of accommodated microorganisms (microbiome) that in many ways form synergies with the body and thus also contribute to an optimal protection. Subjacent defence lines are endogenous antimicrobial peptides (AMP) and the immune system.

Transmission

How can external pathogenic germs then manage to trigger infections in the body? To answer this question, the general transmission routes shall be identified first:

- **Droplet infection:** The aerosols occurring with sneezing or coughing get into the nose or respiratory tract
- **Skin contacts:** Touching, kissing, sexual contacts
- **Smear infection**: Touching of nose, mouth or connective tissue after contact with contaminated objects
- **Skin rubbing**: Chafing, diaper rash etc.
- Bad **food** and germ-infested **water**
- **Injections**, **blood transfusion** and **insect bites**

Not every individual shows the same sensitivity and falls ill, or in other words, people have a different kit of different defence lines. Also other external circumstances have to be mentioned in this context.

Barrier disorders

It is a fact that the number of respiratory tract diseases and barrier disorders such as neurodermatitis increases with the beginning of the cold season to reach its peak at early spring. This also applies to the course of influenza infections and skin problems in the professional field in the form of eczema due to the frequent hand contact with industrial fluids and chemicals.
Why is that? During winter season the condition of skin and mucous membranes continuously deteriorates. This is mostly due to missing sun exposure and exercise routines and also because people stay inside. The most important stress factor, however, is the low air humidity that causes the transepidermal water loss to increase and the skin and mucous membranes to dehydrate, in particular in elder people. Consequences are a disordered skin barrier and nasal mucopolysaccharides that are no longer capable to inactivate external bodies by preventively enclosing them.

Fig: Some examples for air humidity

Outside temperature, night	Outside air humidity, night	Inside temperature	Inside air humidity
10 °C	100% (fog, October)	20 °C	50%
0 °C	100% (hoarfrost, November)	20 °C	25%
0 °C	50% (north-easter, March)	20 °C	12%

The air humidity still is lower with lower outside- and higher inside temperatures with the latter often being the case. The transepidermal water loss (TEWL) of the skin and the dehy-

dration rate of the nasal mucous membranes are increasing at an exponential pace. The risk of infection rises to the same extent since the permeability of the skin and mucous membranes for viral and bacterial germs also rises sharply.
Hence the most effective preventive measure against infections in winter is to lower the room temperatures and wear warm clothing instead of short-sleeved shirts or blouses. It moreover saves money and spares the environment!
With the rise of the outside temperatures in spring and summer also the air humidity in the interiors of houses increases. The permeability of the skin and mucous membranes is balancing in to a normal level. The infection rates are decreasing and influenza and Co. come to a standstill on condition that part of the population has developed a certain immunity; a fact that unfortunately does not apply to the new coronavirus SARS-CoV-2.
Low air humidity and dry skin also are steady companions of the cabin staff in airplanes. The dehydration there still is aggravated by the 20% reduced air pressure.

Skin protection plan

Frequent hand washing including disinfecting measures as e.g. with preparations high in alcohol content in principle is the right thing to do to prevent infections, although frequent hand washing and disinfecting can lead to skin barrier damages. These have to be balanced out with effective skin care and skin protection creams since the skin otherwise becomes cracked which makes it even more permeable for germs and other microorganisms.
Skin protection plans as demanded by the respective occupational insurance associations for the medical sector but also the industrial field are an integral component not only for skin protection but also for the protection against infections. Such plans stipulate specific preparations to be used for the cleansing after work, skin protection during work and the recovery in the time off work.

Too much of a good thing

In the times of spreading infection diseases but also in normal times people at home often overdo cleansing routines and body hygiene.
There is a vast supply of cosmetic and medical preparations on the market and people, full of good intentions, are tempted to do the very best for their body. The opposite is true, though, in particular when the natural barrier substances of the body are again and again washed out and the natural skin flora thus becomes disturbed. Some examples in the following:

- **Foot fungi** can spread very well when the barrier substances are washed out and the horny layer is swollen due to the wet conditions. Barrier disorders can aggravate and inflammations and bacterial infections can follow.
- **Dandruff** also is a consequence of a local fungus infestation. The fungi provoking the condition also can be found on healthy skin and only spread after inadequate and too frequent cleansing of the scalp.
- **Genital area:** Disorders in this area are triggered by depilation, genital douches and tight clothes. Vaginal creams, above all the medical preparations containing preservatives considerably affect the natural microflora and can provoke resistances.
- **Acne:** Skin care preparations containing high amounts of inappropriate lipid substances support the growth of anaerobic germs.
- **Rosacea:** In the case of a genetic disposition, fruit acid peelings can be the triggering factor for the development of the anaerobic flora, that similar to acne, reacts to covering lipid substances with sudden proliferation and then requires treatments with antibiotic pharmaceuticals.
- **Perioral dermatitis** often is a consequence of too much skin care – in the form of too much cleansing and the use of inappropriate skin care products. Also in this case the facultative pathogenic germs are the perpetrators that find ideal living conditions in the disordered barrier.
- **Neurodermatitis**: It is a fact that individuals with a predisposition for this indication which also is related to barrier disorders often take two showers a day just for fear of local infections – including the use of body cleansing agents. This routine of course is counterproductive too, since the increasing deficit of natural barrier substances cannot be compensated with skin care substances.

Chain reaction

Particularly in the case of serious infections also a chain-linking of factors can be identified:

- The barrier or the mucous membranes are pre-damaged as described above either due to predisposition, seasonal or culture-related reasons. The permeability of the skin thus is increased.
- Bacteria with their enzymes additionally break down the protective substances.
- Hence the way is cleared for viruses to penetrate to their host cells.

In the case of common colds the inverse order leads to the greatly feared pneumonias – which also might play a decisive part in the case of the SARS-CoV-2 virus. The viral infection opens the doors for instance for Pneumococcal bacteria which meanwhile are very hard to be held at bay due to a growing resistance to antibiotics. A prophylactic vaccination against pneumococci can be helpful, in particular for elderly persons. A pre-damage due to asthma also involves a certain risk.

Reduction of germs

The spreading features of microorganisms and viruses regarding the contact with contaminated skin, surfaces and liquids are varying. It has been proved that HIV viruses, for instance, cannot be transmitted via skin, saliva and an intact skin barrier. As a general rule it can be said, that a transmission via germ-infested smooth surfaces (metal, glass, plastics) is more likely than via porous, absorbent surfaces such as paper or not treated wood. Smooth surfaces are easier to disinfect, though.
Oxidation agents such as hydrogen peroxide, aldehydes and quaternary ammonium salts diluted in alcohols such as ethanol or isopropyl alcohol are used as disinfection agents, among others. Pure alcohols are most efficient in concentrations around 60-80%. Soap bars and liquid soaps are sufficient for removing viruses from hands. It should be mentioned that viruses cannot survive in opened liquid-solid cosmetic preparations.

Tip: The personal way of life is an important co-factor to activate the natural defence mechanisms of the body. Cold showers to cause the emission of adrenal hormones and an increased microcirculation after exercising are tried and tested beneficial resources, even free of charge.

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