# Unit 1 - Conceptual derivation, definition and delimitation

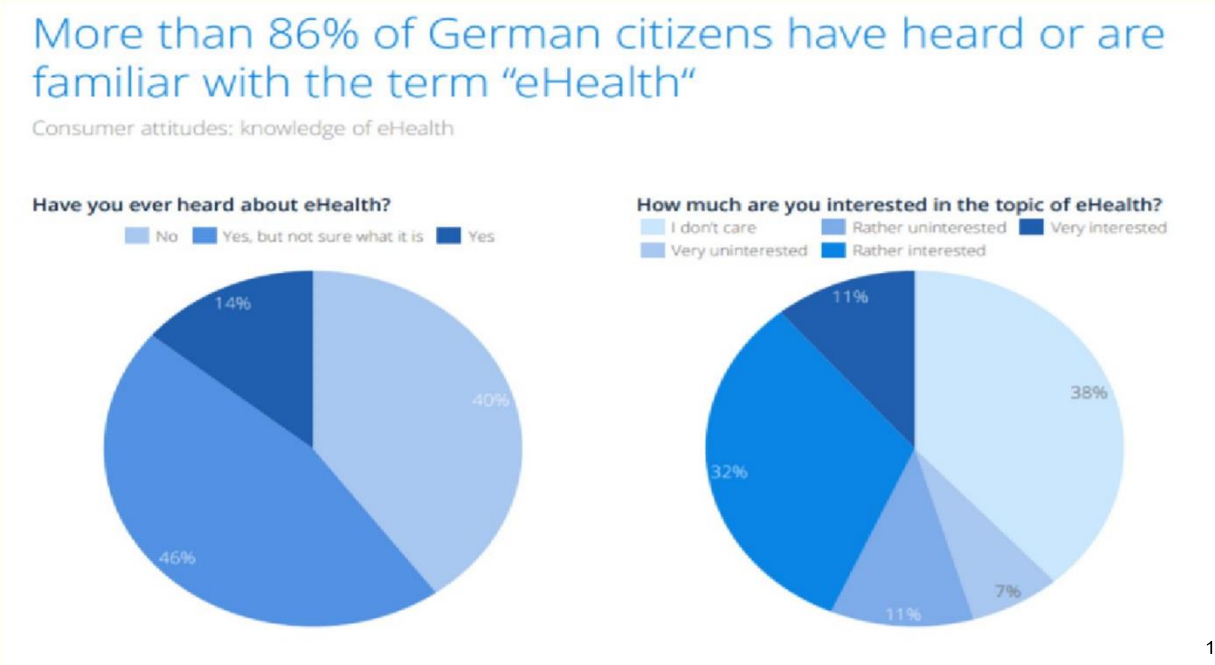
## 1.1 Definitions and conceptual delimitations eHealth

The Federal Ministry of Health in Germany describes the comprehensive term E- Health, as follows:

E-health refers to applications that use the possibilities offered by modern information and communication technologies (ICT) for the treatment and care of patients. E-health is a generic term for a broad spectrum of ICT-based applications in which information can be processed electronically, exchanged via secure data connections, and treatment and care processes for patients can be supported. This applies, for example, to the communication of medical data made available with the electronic health card, such as emergency data or the medication plan, the electronic patient file and also telemedicine applications. Communication of this sensitive health information will take place via the secure telematics infrastructure.

These can be services in the treatment process (e.g. electronic physician's letter) or in the administrative area (e.g. hospital invoices to the health insurance company for services rendered).

The Swiss Society for Telemedicine and eHealth generally defines eHealth (SGTMeH) as the integration of information and communication technologies (ICT) into healthcare.

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Source: https://de.statista.com/statistik/studie/id/50712/dokument/ehealth-market-report-germany/, retrieved on 11.03.21

# Health Telematics

Health Telematics has two important goals:

1. Improvement of medical care
2. Simultaneously reducing costs.

Against the backdrop of demographic developments with increasingly older people, some with chronic and multiple illnesses, the rural exodus and the shortage of doctors in rural areas, health telematics is designed to help. It's intend is to make medical services in the areas of prevention, treatment and rehabilitation accessible to all citizens, including those who live 50 km away from their nearest specialist.

The terms used in connection with health telematics have often developed one after the other and are often also used synonymously. Health telematics, telemedicine, eHealth and telematics in healthcare are examples of terms that sometimes have the same meaning or are also used in different contexts.

It becomes apparent that a clear categorization is rather difficult. However, it is evident that terms such as eHealth or health telematics not only relate to the treatment process, but also to the areas of administration and training.

Telemedicine

The World health organization describes the term telemedicine as follows:

"*Telemedicine involves the delivery of health services using ICT, specifically where distance is a barrier to health care. It falls under the rubric of eHealth.* "

The Swiss Society for Telemedicine and eHealth defines telemedicine as a section of eHealth. The main focus of telemedicine is on the interaction between:

- Patient and physician (teleconsultation)
- or numerous physicians (telecouncil)
- in connection with medical diagnostics or treatment, whereby the parties involved are not in direct physical contact with each other.

The unique nature of telemedicine stems from the fact that the bridging of distance is supported by the use of technological and other means of communication.

Internationally, terms are sometimes replaced by proprietary variations. In Canada and Australia, the term telehealth is used, while telemedicine is common in the USA.

A fundamental distinction can be made between two systems for the use of telemedicine applications. These are the systems referred to in the specialist literature as Doc2Doc and Patient2Doc.
The field of telemedicine includes not only strictly advisory applications, such as consultation of the doctor by the patient or teleconsultation. Telemonitoring now also accounts for a large proportion of telemedicine applications. Examples include the transfer of measurement data collected by the patient himself/herself, such as body weight, blood glucose values or lung function readings, to the primary care physician or an expert.

All telemedicine applications have in common, that a physician's expertise is also available when he or she is not physically at the patient's location. The physician who consults the expert is therefore able to start therapy or make a diagnosis immediately without having to travel long distances and lose time. In the case of telemonitoring, the physician who examines the measured data can act without delay and initiate the right therapy for the patient if necessary, including ambulance transport in the event of a life-threatening emergency.

## mHealth or mobile Health

mHealth is telemedicine in a mobile environment. Data is recorded while the patient is out and about. In the medical environment, these are the same parameters as in telemonitoring. The measuring devices themselves communicate with a built-in radio module directly or via a smartphone with a medical center or an App on the smartphone itself, which analyzes the readings and displays the results. Smartphones are simply the best example as a mHealth platform, because they enable patients to be contacted directly or information to be made available to them. Yet sensors, such as the GPS system, can be useful as well, for example, in emergency medical services when it is necessary to locate a patient in need of immediate medical assistance.

[2] cf. http://www.aerzteblatt.de/archiv/45514

It is not only the use of smartphones, tablets and the like that is becoming increasingly important, but also the use of Apps and mHealth. The following statistics show the projected size of the global mHealth market from 2016 to 2025. In 2021, the global mHealth market is expected to reach almost USD 100 billion. This would be a five-fold increase from approximately $21 billion in 2016.

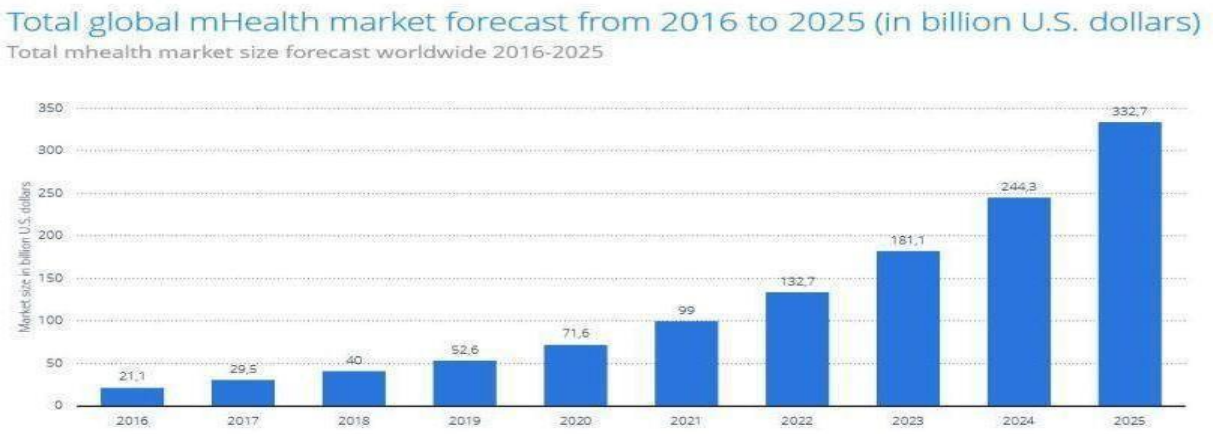



**Figure 1: Global mHealth forecast3**

## Quantified Self

Quantified Self, self-measurement or self-tracking

It refers to the voluntary collection of biometric data, in other words data generated by the body, or external parameters that are relevant to the organism. The simplest example is the pedometer, which quantifies or measures our daily movement. Currently, so-called wearables, measuring devices that can be worn as clothing or in other forms, are on the rise. Wristbands measure pulse rate, skin resistance or body temperature, T-shirts register ECG and respiratory rate, e.g. during sports.

Apps for smartphones are also used. For example, a motion sensor in the smartphone which is placed on the mattress can determine the type and depth of sleep.

The boundaries between Quantified Self and eHealth are fluid, and it can be anticipated that many more applications will emerge from the self-tracking sector that can be usefully deployed in the medical environment as well.

[3] Quelle: http://www.statista.com/statistics/938544/mhealth-market-size-forecast-globally/

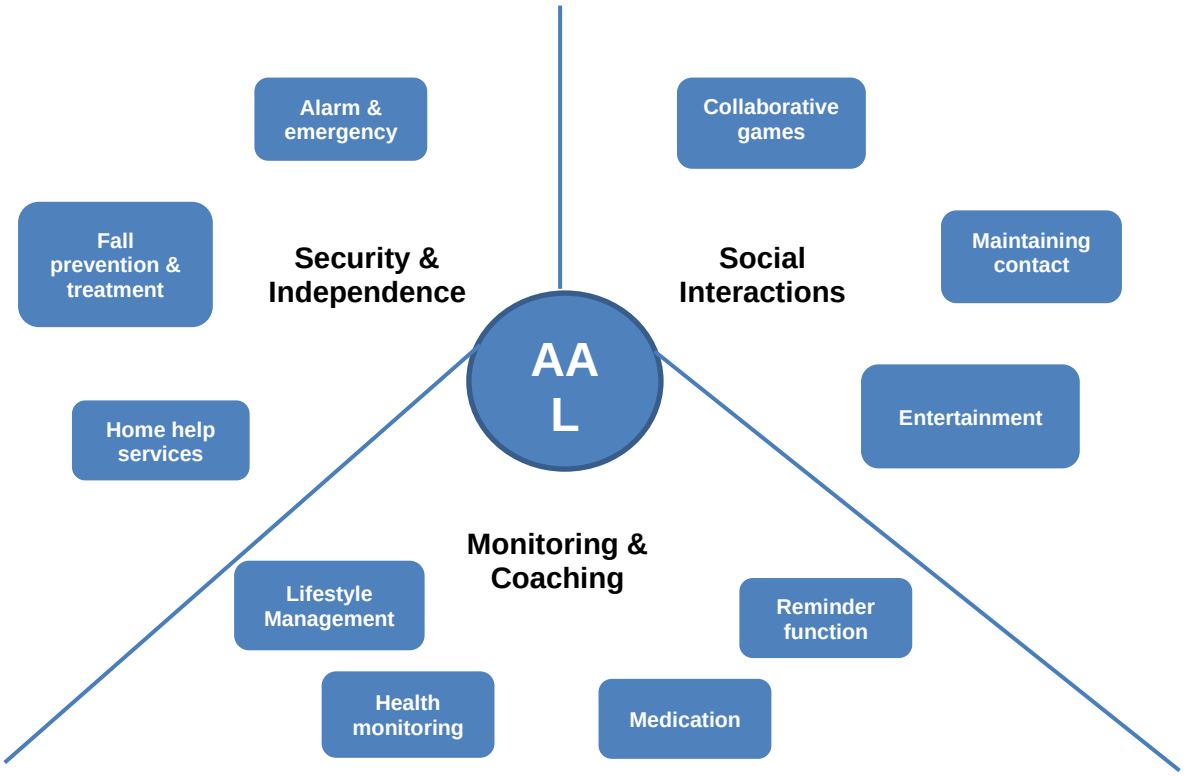
## Ambient Assisted Living

In Ambient Assisted Living or AAL technologies, technical assistance systems help the individual and patient to move around more safely in their private environment. The intention is likewise to increase participation in life outside one's four walls and mobility. The target group consists of people who, due to personal circumstances, are only partially able to function on their own. The need for such assistance systems exists primarily among senior citizens with many limiting illnesses, among physically and mentally disabled individuals, and also generally for those whose provision of care is restricted. The provision of care here concerns both the needs of everyday life, as well as medical care. Dementia patients are being helped by assistance systems to find their way around in their personal environment, they enable communication with relatives or friends via age-appropriate communication systems, they provide support when shopping for groceries or make it easier to board the bus. Barrier-free accessibility is closely related to AAL. Voice control of home lighting, shutters or heating is a further example.

From a medical perspective, AAL technologies complement pure telemonitoring, which covers a wide area in the field of AAL. The best example is the home emergency call. Fall sensors in the floor or sensors in the bed that sound an alarm if the user gets up at night and does not return are also examples of medical-associated AAL systems.

The goal is still to make these support systems as unobtrusive as possible, which means making them invisible or well-adapted to the living environment so that the presence of technical devices does not interfere with everyday life. AAL systems are essentially very broadly oriented and can address different target groups through the range of application scenarios.

**Figure 2: Overview of AAL application areas**




[4] Source: own representation

Due to the interdisciplinary nature of AAL systems, in addition to their function of supporting the everyday lives of older people to the extent that they can continue to lead independent life in their own homes, they also have a high benefit potential for young people, for example in the form of intelligent control systems. This results in a possible subdivision of the target group of AAL systems into:

- Direct beneficiaries (e.g., functionally and mobility impaired people; high-risk patients; chronically ill or very old people, people with dementia, people with high comfort and safety needs),
- indirect beneficiaries (e.g., family caregivers; outpatient care services, etc.),
- Other beneficiaries (e.g., payers; housing industry; municipalities/cities/communities, etc.) and/or
- other target groups (e.g. politics, senior citizens' associations or self-help groups, etc.).

## Medical Devices

By definition, medical devices are products, devices and software with a medical purpose, which are intended for "[...] use on humans [...]"[6]. It is precisely this mainly physical application of medical devices that differentiates them from drugs. Well-known examples of medical devices are:

- Medical software
- Implants
- Products for injection
- Infusion, transfusion and dialysis
- Human medical instruments
- Pacemaker
- X-ray equipment

Special legal stipulations and requirements apply to manufacturers for approval of their products as medical devices. In Germany, for example, these are regulated in the Medical Devices Act (MPG). [7]

[5] cf. http://www.dke.de/de/std/aal/documents/deutsche_normungs-roadmap_aal.pdf p. 26

[6] http://www.bmg.bund.de/gesundheitssystem/medizinprodukte/definition-und-wirtschaftliche-bedeutung.html

[7] cf. http://www.gesetze-im-internet.de/mpg/BJNR196300994.html

## Medical Informatics

The purpose of medical informatics is the computer-controlled systematic processing and preparation of information in medicine or healthcare. This is done, among other things, by modeling information-processing systems. Specific areas of medical informatics include the following:

- Analysis, planning and implementation of information systems for medical practices,
  Hospitals, company physicians, health insurance companies and public health departments
- Organizational analysis and organizational design in medical facilities
- Implementation and support of application systems in health care facilities.
- Establishment and maintenance of medical coding and documentation systems
- Connection of medical technology systems to information systems and measured value processing/analysis
- Connection of imaging methods to information systems and image processing/analysis
- Development of teaching and learning systems
- Establishment and maintenance of literature and knowledge databases for use in decision support
- Establishment and operation of telematics procedures in the healthcare sector
- Development and implementation of quality assurance concepts
- Development and maintenance of databases for epidemiological studies
- Technology and organizational consulting of health care institutions.

Medical computer scientists develop, operate and evaluate infrastructures, information and communication systems including those for medical devices. Medical informatics understands these as socio-technical systems whose working methods are in accordance with ethical, legal and economic principles.

It is evident that medical informatics covers the entirety of information processing, from data creation to processing and archiving. Telecommunication matters only in some areas. The techniques included under eHealth or telematics in healthcare are therefore only a subset of medical informatics.

[8] cf. http://www.gmds.de/organisation/zertifikate/zusatzbezeichnung_informatik.php
[9] http://www.bvmi.de/medinf

## 1.2 Exemplary application examples and technologies

### Telerobotics - Da Vinci Surgical System

*Medical robotics* is the use of robots in medical care, rehabilitation and nursing. Examples include surgical robots for interventions in orthopedics or (neuro)surgery, nursing robots with video conferencing solutions for contact between the nursing service and the person being cared for, or robotic systems to compensate for the loss of functions of the body (e.g., exoskeletons for paraplegics).

*Telerobotic systems* are extended by a remote control component. Surgical robots arecontrolled by the surgeon from control consoles close to the patient in the operating room. By using joysticks, accuracy can be increased as movements can be more finely graduated compared to what the physicians hand would be able to do. An example is tissue sampling in the brain with the help of robots (stereotaxy). Here, unwanted movements (twitching, trembling) can be filtered out, which increases the protection of the surrounding tissue.

The Da Vinci Surgical System assists the surgeon during endoscopic procedures. This gives him up to 10x magnification and 3-D imaging during operations on prostate or urinary bladder carcinomas, for example.

**Figure 3: daVinci robot system[10]**

[10] Source: https://www.asklepios.com

## Ambient Assisted Living - "DeinHaus4.0" –

## Living at home for longer

The research project "DeinHaus4.0" of the Deggendorf Institute of Technology deals with the topic of AAL and wants to make it easier for people with care and/or assistance needs to live in their own four walls with technical-digital support. The own house, the own
apartment, will thus become part of the treatment, rehabilitation and care provision in the future. Interested parties can take a look at model facilities with corresponding technology for the various forms of living, such as one's own house, one's own apartment and a room
in a nursing home. Examples of the built-in technology include a stove monitoring sensor, medication dispenser or door sensor. This technology is intended to make life in old age easier for both the residents themselves and their relatives.

Locations for the model homes and apartments are Osterhofen, Freyung, Deggendorf and Cham.

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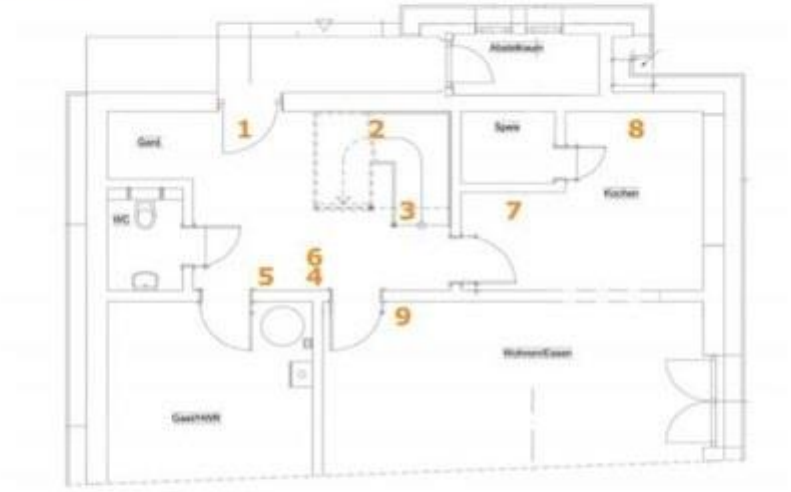
"The door/window sensor reports whether the door or window is open or closed. The motion sensor informs whether motion has been detected in this room. The temperature/humidity sensor measures the temperature and humidity content of the room air. However, the interaction of these sensors is particularly interesting. Thus, if the room temperature is poor or the humidity is too low (dry air), a message can appear prompting the occupantsto ventilate. The well-being can be increased by the better room climate. Likewise, the person can be reminded if the door or window is left open too long or if the heating is running at the same time. All installed sensors are to be connected with each other, whereby a constant exchange of data can take place. For example, an automatic LED light with built-in motion sensors can not only be used to prevent falls, but also to record and analyze motion profiles. A person's movement pattern is strongly related to his or her state of health, because the more someone moves, the fitter and healthier he or she usually is.

[11] https://deinhaus4-0.de/wp-content/uploads/2020/11/dh40_imagebrosch%C3%BCre_a4_web.pdf retrieved on 01.03.2021

SAMPLE HOUSE

1. Door sensor
2. Motion detector
3. Light bar on the stairs
4. Base station
5. Mobile
6. Smoke detector
7. Drug dispenser
8. Stove shutdown
9. Voice Assistant
10. Nightlight with motion sensor
11. Robot vacuum cleaner
12. Emergency button / Panic alarm
13. E'Book Reader
14. Sleep sensor
15. Lowerable clothes rail





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Further information on the "DeinHaus4.0" project can be found on the homepage of the Deggendorf Institute of Technology or the homepage of "DeinHaus4.0": https://deinhaus4-0.de/start/

Under the following link you will find a video about the research project:

[12] https://deinhaus4-0.de/wp-content/uploads/2020/11/dh40_imagebrosch%C3%BCre_a4_web.pdf, retrieved 01.03.2021
https://www.stmgp.bayern.de/presse/huml-foerdert-modellprojekt-deinhaus-4-0-der-technical-university-deggendorf-with-knapp/

## Telemedicine

Telemedicine has a wide variety of application areas and uses. What they all have in common is the transmission of information between persons, but also between systems.

An example: As a patient, you call your doctor and tell him that you have measured a blood pressure value of 240/130 mmHg (normal 120/80 mmHg). Your doctor advises you to come in immediately or go to the hospital. This is telemedicine between people. You measure a blood pressure value of 240/130 mmHg (normal 120/80 mmHg) with your blood pressure monitor, which the device automatically transmits via the Internet to an information system at a medical expert center. The system there automatically detects the dangerously high blood pressure reading and alerts a physician at the expert center.

This person contacts you and advises you to come in immediately or to go to a hospital. It' s telemedicine, first between systems and later between people.

It is therefore a matter of transmitting information, with the expertise of a medical professional playing an important role in telemedicine procedures.

**Figure 4: Satellite-based transportable telemedicine system[13]**

[13] Source: German Aerospace Center - DLR e.V.

## Image transfer

The transmission of visual material in various forms to an expert for diagnostics is certainly one of the most common telemedical services.

Radiology is the medical discipline that was the first to work with digital image data. CT images are the result of digital calculations from absorption values of gamma radiation and not traditional X-ray film. In the meantime, almost all diagnostic documents in radiology can also be created digitally (digital X-ray) or digitized by scanning.

*Teleradiology* is the transmission of digital radiology reports for the purpose of evaluation by a radiologist or just for archiving at another location.

Microscopic images play an important role in pathology.

These can either be digitized/photographed at the site of origin and then transmitted (store and forward process) or transmitted live as high-resolution video. The microscope can
also be controlled by the remotely located pathologist. In this case, it is a telerobotic procedure. The benefits of *telepathology* are time savings with positive effects on costs and patient safety.

One example: If breast cancer is suspected, a so-called frozen section examination is most commonly performed. The tumor is removed and taken to the pathologist by courier. The pathologist prepares sections of the specimen, microscopes them and reports back to the surgeon whether the tumor has been completely removed or whether a more extensive operation is needed the same day. The patient (5% men as well) is then brought back to the operating room, anesthetized and operated on.

With telepathology, the frozen section is made in the operating room and the pathologist diagnoses promptly on the basis of the transmitted visual material. If necessary, the operation can be continued immediately.

The advantages on the financial side relate to costs for double staffing in the operating room and recovery room, courier and cleaning, and possibly also keeping the Operating Room ready. The patient is not subjected to the potential risk of a second anesthetic.

*Teledermatology* is the transmission of images of the skin produced by digital cameras or digital dermatoscopes. In *teleophthalmology*, digital ophthalmoscopy images are transmitted to the ophthalmologist for evaluation.

In addition to other organizational and legal factors, it should be noted for the above- mentioned methods with image data transmission that diagnostics is only permissible on the basis of loss-free transmitted image material. If image data are being compressed, only loss-free compression algorithms should be used in order to prevent compression artifacts.

**Provision of therapeutic services**

Many telemedical procedures are based on the transmission of video data. This can be unidirectional, from the physician to the patient, or bidirectional (video conferencing).

*Telerehabilitation* uses the transmission of video data, filming the patient performing physiotherapy or speech therapy exercises, for example. Here, too, live and store-and- forward methods can be used.

However, it often makes sense to assess the exercises live in order to be able to provide guidance to the patient on how to perform them. The store-and-forward method only offers the possibility of subsequent assessment and subsequent transmission of correction suggestions.

The use of *telepsychiatry* and also *telepsychology* in diagnostics and therapy is of course of great benefit when the patient and the doctor or therapist are so far apart thatregular travel is only possible at great expense in terms of time and money, or not at all. The basis of telepsychiatric therapy is video conferencing. The procedure has been practiced for more than 20 years, for example, in Scandinavia and Great Britain, that is, mainly in large states with remote areas and long distances between the doctor and the patient or in states with many inhabited islands where no psychiatrist is available.

Teletherapy is also conceivable in principle for other areas. Remote-controlled insulin and painkiller pumps do not pose a technical challenge. However, such systems must be protected against unauthorized access and must not allow overdoses. So far, such systems have not been used.

## Telemonitoring & Telemetry

As mentioned at the beginning, data from medical measuring devices can be transmitted directly. Similar to monitoring in an intensive care unit, where data from such devices as ECGs, ventilators, or blood pressure monitors are transmitted to the central monitoring station, telemonitoring involves transmitting data from non-inpatients to specialists.

The principle is always the same. The patient records data with measuring devices in his or her personal environment, which are then transmitted to an expert who evaluates them and takes action if necessary.

Telemonitoring plays a major role due to demographic developments. Life expectancy is increasing and with it the incidence of chronic diseases in old age. In addition, most people would like to remain in their home environment as long as possible.

In addition, older people want to feel safe while they are mobile. Moreover, telemonitoring offers the possibility of establishing contact with the doctor and nursing staff while at home or on the road. Of course, telemonitoring is also interesting for risk patients of any other age group.

Thanks to the possibilities of mobile data transmission, telemonitoring can also take place outside the home environment and thus contributes to mobility and quality of life. Measuring devices that are frequently used in telemonitoring record body weight, ECG, blood pressure, blood sugar, coagulation parameters or lung function.

Telemonitoring eliminates the information deficit that occurs between two visits to the doctor or speeds up diagnostics. In the event of a suspected heart attack, for example, the patient is able to immediately send a self-generated ECG to an experienced physician, who can then initiate emergency measures in the event of a positive result.

Examples of a positive effect on costs in the care of chronic patients are heart failure and asthma/COPD. In the case of the heart failure patient, body weight is monitored. If there is a rapid increase (several kg over a few days), therapy must be adjusted. If this is not done in time, inpatient treatment is required. Asthma or COPD patients must adjust their medication if their lung function deteriorates, otherwise pulmonary decompensation will result in a long, expensive course of inpatient treatment that is stressful for the patient.

Telemetry refers to the technical process of transmitting measured values,

telemonitoring to the telemedical process of monitoring measured values of individuals. However, telemonitoring is also useful in the field of prevention. This is where the boundaries to Quantified Self (see below) are blurred.

## Teleconsultation

Teleconsultation is the most commonly practiced telemedicine application. Without the physicians being aware of it, when they discuss a case with a colleague on the phone, they fulfill the above-mentioned criteria for telemedicine, namely *interaction of numerous physicians (teleconsultation) in connection with medical diagnostics or treatment, whereby the parties involved are not in direct physical contact with each other.* The supplementary component of remote transmission of medical data is realized when the colleague is additionally faxed diagnostic reports. Neither fax transmission nor telephone calls are particularly secure against unauthorized access, and we frequently receive reports of sensitive diagnostic documents being sent to incorrect fax numbers. It therefore seems sensible to develop solutions that are secure and offer additional options.

In the context of health telematics, *teleconsultation* is understood as telematic contact between numerous physicians or between physician and patient or nurse practitioner /paramedic. The areas of application are multifaceted. The first widespread teleconsultation systems were the video conferencing systems frequently used in the business sector. The advantage of such systems is that the patient and his findings can be presented live to a medical expert. He can also questionthe patient.

However, a major deficiency was the lack of an option for transmitting diagnostic results. Modern video conferencing systems therefore offer the option of additionally transmitting data and viewing and discussing them together (whiteboard function).


**Figure 5: Teleradiology system with video conferencing component forteleconsultation[14]**

Teleconsultation systems are used where on-site physician expertise is not available.

In addition, the systems generally offer the possibility of including several participants in a video conference and are therefore often used within hospital associations and physician networks for quality circles and for continuing education. Examples of these quality circles are:

- Oncology case conferences of several oncologists to determine optimal therapy
- Radiological case conferences in which radiologists from several sites of a network discuss unclear findings
- Quality circles in physician networks, in which current standards for the diagnosis and therapy of relevant clinical pictures are developed as part of ongoing training.

It is also important that a diagnosis by an expert is only permissible on the basis of findings transmitted loss-free (especially image data).

[14] Source: German Aerospace Center - DLR e.V.

## Other areas of application

Where medical data is generated in digital form, the step to a telemedical application is notfar away and therefore many procedures only differ in the type of data transmitted and less in the technology underlying the application.

Teleradiology, teledermatology, telecardiology, telepulmology and other telemedicine procedures are based on the transmission of diagnostic data and their evaluation by a medical expert.

Procedures in which video signals are transmitted live to an expert so that he or she can support the examination or treatment process are called *telepresence.* Examples of this are:

- *Telegrastroenterology*, in which an endoscopy video is transmitted live to the expertto assist the examiner on site
- *Surgical telepresence,* in which the remotely located expert virtuallyattends a surgical procedure.
  (Not to be confused with telerobotic surgery, in which an expert remotely controlsa surgical robot. This did not catch on following a few pilot projects, as a surgeon still has to be on site in case complications arise (e.g., vascular injury). Tele-robotic surgery takes place in the operating room, for example, during procedures inside the skull. Here, the robot is located at the patient and the surgeon at a console in the immediate vicinity.
- *Telesonography*, a fairly common procedure in states with vast territories in which the ultrasoundvideo is transmitted to an expert.

All methods are of course also suitable for transmission into the (virtual) lecture hall for thepurpose of medical education and training, *teleteaching.*

A very useful area of application for teleconsultation concers the treatment of strokes. In this case, a patient with a suspected stroke is taken to the nearest clinic equipped with a computer tomograph. The findings are then transmitted to a neurologist at a key hospital, who then decides immediately which therapy is most appropriate. In this way, valuable minutes are saved until therapy commences. This is a clear advantage for the patient and reduces complication-related follow-up costs. The procedure is an example of *teleneurology.*

In *teletraumatology,* data on the findings of accident or trauma patients

from regional primary care hospitals are transmitted to a medical expert at a trauma center (often a university hospital). The physician then decides whether the patient must be transferred to a hospital with a more advanced level of care or whether therapy can be carried out locally. In this way, cost-intensive incorrect transfers (lightly injured patient in trauma center with transfer to a primary care hospital) can be avoided in particular. A seriously injured patient is transferred to the right facility in a timely manner.

## mHealth apps

Smartphones support medicine and care and help maintain high-quality medical care despite dwindling financial and per capita human resources. They can be used by seniors and the chronically ill. However, they are only suitable to a limited extent for people who have developed reduced mental abilities (dementia patients) or people who have missed out on the age of cell phones and computers (one- or zero-button technology). Smartphones allow for increased social engagement and strengthen autonomy and mobility of the individual. In addition, they promote care with a focus on the individual.

"Acceptance of new med. procedures such as telemonitoring will come directly from consumers, who can be won over to mHealth (mobile health) and eHealth through their smartphones. Hardware peripherals (medical meters for e.g. blood pressure, blood glucose, lung function, body weight) that are capable of interoperating with mHealth apps will enable the smartphone to act as a key portable accessory for diagnosing and relaying medical data to medical providers. mHealth app downloads are increasing from 44 million in 2012, to 142 million in 2016. "[15]

**Figure 6: mHealth app[16]**

[15] Juniper Research (UK) 2013

[16] Source: German Aerospace Center - DLR e.V.

mHealth apps differ from medical apps in that they are not medical devices. A medical diagnosis on the smartphone based on data collected by the user with measuring devices is not performed by mHealth apps. In this case, the app would have to be classified as a medical device. Medical apps certified as medical devices are still rare and are used in the medical environment by physicians and care providers. mHealth apps support patients in managing their data, offer support for healthy behavior and increase therapy adherence.

## Wellness and lifestyle products

Advances in miniaturization in microelectronics are accompanied by the availability of ever smaller sensors that, either built into smartphones or devices such as pedometers, wristbands, clothing or smartwatches, measure not only medically relevant data such as breathing rate or pulse rate, but also other data such as skin conductance, acceleration, sleep-position or movements of the body during exercise.

The measured data is then either transferred to the smartphone, where it is processed in mobile health apps or mHealth apps, or uploaded to manufacturers' servers, where analysis takes place.

## Quantified Self

Self-measurement (quantified self) goes far beyond telemedical applications. Its objective is to collect all kinds of data about activities, habits, or relationships that help to understand and improve one's own behavior, health, or well-being. In general, there has been a change of mindset compared to traditional telemedicine. The focus is now on the individual in their entirety, the individual being at the center. An increasing number of people want to learn more about themselves. In telemedicine, on the other hand, the focus is on the questions posed by the attending physician.

This measuring of one's own body is in vogue. The motivations are very different. Many people want to optimize their performance, especially athletes. Others have medical reasons and want to stay healthy or become healthy. Finally, there are those interested in technology who want to try out the latest wearable sensors and the latest smartphones and apps.

Self-measurement has a whole range of positive effects. From a medical point of view, it promotes acceptance of regular self-monitoring. Patients also have

increasingly more possibilities to carry out measurements themselves, saving the need for many a trip to the doctor. This also creates a certain degree of independence.

Immediate self-awareness, which comes about without a detour via medical professionals, increases the motivation of many people to deal with their own bodies. But there are also advantages for medical professionals. The continuous recording of data which individuals then bring to the doctor's office can lead to better decisions and higher therapeutic success. Modern methods for analyzing large amounts of data from different sources make it possible for software to automatically recognize what is wrong with a person. These so-called Big Data methods already allow complex questions to be answered and correlations to be revealed. This is not just about staying healthy or getting healthy. In today's performance society, self-measurement with the purpose of self-optimization can help to achieve higher performance. This can certainly lead to increased productivity at work or to better athletic performance. Likewise, the exchange with like-minded self-measurers helps to increase motivation and thus performance.

## Fitness bands

So-called fitness bands measure acceleration, skin conduction resistance, pulse, position of the individual and offer such additional options as the display of the collected data, a notification when, for example, a predefined number of steps has been reached. Fitness wristbands communicate via Bluetooth or USB with smartphone and/or computer.

**Figure 7: Fitness wristbands[17]**

[17] Source: German Aerospace Center DLR e.V.

## Fitness shirt

Fitness shirts have built-in and washable sensors. They measure pulse rate and respiration and, depending on the equipment, can communicate directly, that is during the training, with apps on the smartphone or transfer the data there after the workout.

## Smart Watch

Smart watches are currently experiencing an incredible boom. For some time now, watches from sporting goods manufacturers that accept data on pulse and respiration from sensors in chest straps, for example, and display it during training have been widespread among athletes. With smart watches, functionalities of smartphones are now finding their way into the smart watch on the wrist. Smart watches have sensors to measure acceleration and position, skin conductance or pulse rate. They can have actuators (vibration motors) and have a display. Apps can also be installed on smartwatches, just as on smartphones.

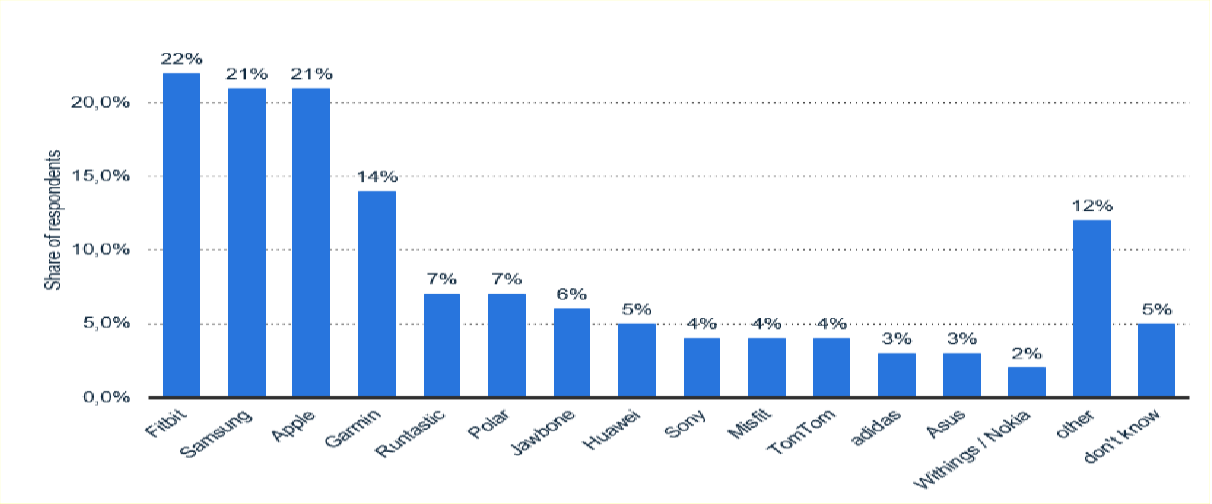
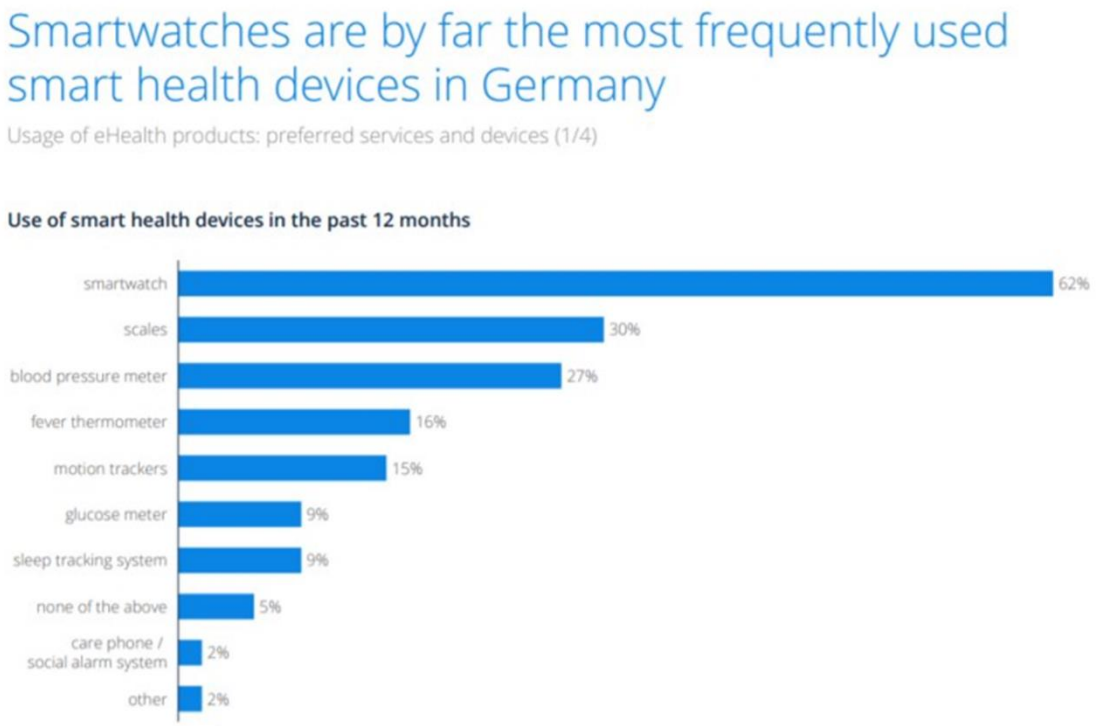



Figure 9: ehealth tracker/smart watch ownership by brand in Germany 19

The data displayed on the ownership of eHealth trackers / smartwatches shows results from the Statista Global Consumer Survey, which was conducted in Germany in 2019. Around 3 percent of respondents answered ''adidas'' to the question ''Which brands are your personal smartwatches / fitness trackers?''. The Statista Global Consumer Survey provides a global perspective on consumption and media use, covering the offline and online worlds of consumers.

[18] Source: https://pixabay.com/images/id-828786/ (accessed on 03.11.2020)

[19] Quelle: https://www.statista.com/forecasts/998716/ehealth-tracker-smart-watch-ownership-by-brand-in- germany retrieved 20.11.2020




According to a 2018 survey on the use of connected health devices in the last 12 months by Statista Global Consumer, smartwatches are the most widely used smart health devices in Germany.

## Smart Glasses

Smart glasses (like smart watches) are wearable computers integrated in a spectacle frame. They can be equipped with a camera to record the environment and have a display to show information about the user's location (augmented reality), which is detected by a GPS module. Some smart glasses can log activities using built-in sensors and display training instructions for the user. Due to the integrated camera, smart glasses have only found limited acceptance as a daily companion. Many people feel they are being monitored and are unsure of what is being done with the recorded image material. Often people request that smart glasses are removed in their presence. In the USA, wearers of smart glasses who ignore this are also bitingly referred to as "gl-assholes".

[20] Source: https://de.statista.com/statistik/studie/id/50712/dokument/ehealth-market-report-germany/, retrieved 11.03.2021

## Literature and internet sources

Ärzteblatt, Telemedicine: Successful Business Models, available at: http://www.aerzteblatt.de/archiv/45514 (Accessed: 02/17/2021).

Berufsverband Medizinischer Informatiker e.V., Medical Informatics, available at: https://www.bvmi.de/med-informatik/medizinische-informatik (Accessed: 03/11/2020)

Federal Ministry of Health, available at: https://www.bundesgesundheitsministerium.de/service/begriffe-von-a-z/e/e-health.html (Accessed: 6/15/2020).

Federal Ministry of Health, Medical Devices, available at: https://www.bundesgesundheitsministerium.de/themen/gesundheitswesen/medizinprodukte.html (Accessed: 02/17/2021).

Federal Ministry of Health, Tasks and Organization of the SHI, available at: https://www.bundesgesundheitsministerium.de/themen/krankenversicherung/grundprinzip ien.html (Accessed: 03/11/2020).

Federal Ministry of Health, Private Health Insurance, available at: https://www.bundesgesundheitsministerium.de/private-krankenversicherung.html (Accessed: 02/17/2021).

Federal Agency for Civic Education, Structures and Utilization, available at: http://www.bpb.de/politik/innenpolitik/gesundheitspolitik/72646/strukturen-und-inanspruchnahme (Accessed: 02/17/2021).

YourHouse4.0., available at: https://deinhaus4-0.de/wp-content/uploads/2020/11/dh40_imagebrosch%C3%BCre_a4_web.pdf (Accessed: 01/03/2021)

Deutsche Gesellschaft für Medizinische Informatik, Biometrie und Epidemiologie e.V., Weiterbildung Medizinische Informatik, available at: https://www.gmds.de/aus- weiterbildung/zertifikate/aerztliche-zusatzbezeichnung-medizinische-informatik/ (Accessed: 02/17/2021).

Games Career, Health Games: Gaming as Therapy, available at: http://blog.games- career.com/en/health-games-gaming-as-therapy-guest-contribution-of-birk-grueling-part-i/ (as of Feb. 17, 2021).

Statutory Health Insurance, § 1 Solidarity and Individual Responsibility, available at: http://www.gesetze-im-internet.de/sgb_5/_1.html (Accessed: 02/17/2021).

Statutory Health Insurance, Section 75 Content and Scope of Assurance, available at: http://www.gesetze-im-internet.de/sgb_5/_75.html (Accessed: 02/17/2021).

Statutory Health Insurance, Section 120 Reimbursement for Outpatient Hospital Services, available at: http://www.gesetze-im-internet.de/sgb_5/_120.html (Accessed: 02/17/2021).

Statutory accident insurance, § 14 Principle, available at: http://www.gesetze-im-internet.de/sgb_7/_14.html (Accessed: 02/17/2021)

Statutory accident insurance, § 26 Principle, available at: http://www.gesetze-im-internet.de/sgb_7/_26.html (Accessed: 02/17/2021)

Medical Devices Act, available at: http://www.gesetze-im-internet.de/mpg/BJNR196300994.html (Accessed: 02/17/2021).

Law on the Marketing of Medicinal Products, available at: http://www.gesetze-im-internet.de/amg_1976/ (Accessed: 02/17/2021).

Act on the Economic Security of Hospitals and the Regulation of HospitalCare Rates, available at: http://www.gesetze-im-internet.de/khg/BJNR010090972.html (Accessed: 02/17/2021).

Federal Health Reporting, Medical Technology, available at: https://www.gbe-bund.de/gbe10/billing.prc_abr_test_logon?p_uid=gast&p_aid=0&p_knot=FID&p_language=D&p_suchstring=9400 (Accessed: 02/17/2021)

Federal Health Reporting, Outpatient Medical Treatment, available at: https://www.gbe-bund.de/gbe10/billing.prc_abr_test_logon?p_uid=gast&p_aid=0&p_knot=FID&p_language=D&p_suchstring=7971 (as of Feb. 17, 2021).

Pelizäus-Hoffmeister, On the importance of technology in the everyday lives of older people,2013.

Statista, available at: https://www.statista.com/forecasts/998716/ehealth-tracker-smart- watch-ownership-by-brand-in-germany (Accessed: 03/10/2021)

Founder association for German science, research and development, available online at:
http://www.stifterverband.de/pdf/fue_facts_2014-01.pdf (Accessed: 02/17/2021)