COM IMMUNITY

In-vivo antivirus scanner to enhance Health and Well-being

BY TEAM CLASH

ABSTRACT

The outbreak of the new Sars-CoV-2 virus 2019 posed and still poses new challenges for us. For many, it is the first pandemic they have experienced. But studies show that this will not be an isolated incident. Factors such as globalization and climate change will continue to promote the outbreak of new viruses in the future [1].

A global immune memory should solve the problem. People in high-risk groups with weakened immune systems can gain access to data on successful immune reactions to viruses and use this information to fight the virus without additional medication. This is made possible by the in vivo antivirus scanner ComImmunity.

With the combination of various new technologies, viruses in the body are detected and analyzed. By modifying the DNA of human B cells, it will even be possible to fight the virus directly in the body. With this new way of treating viral diseases, it is possible to reduce the mortality rate significantly. By integrating the CERN monitoring system REMUS for the continuous generation of a heat map it is possible to intervene at an early stage in case of a viral outbreak and thus prevent a pandemic.

CONTENT

CBI PROGRAM

Team Clash is part of the CBI A³ program.
Do you wonder what this is all about? It's very simple. Challenge Based Innovation (CBI) in general is a project course in which multidisciplinary student teams and their lecturers work together with researchers at CERN to find new solutions for the future of mankind. The projects are a sophisticated mix where societal, human-driven needs meet CERN research.
In CBI A³, which is led by Swinburne University of Tech nology (Australia), students from Swinburne, Mannheim University of Applied Sciences (Germany) and Pace University (USA) work in teams to develop and prototype ideas for the future, linking CERN technology to UN Goal 3 "Good Health and Well-being" for sustainable development by 2030. [2]

2

TEAM CLASH

Clara is a Biomedical Engineering Master student at the University of Applied Science in Mannheim. During her studies, she focused on high-frequency hardware-based medical research and medical imaging. She is pleased to have been given the opportunity to combine her two fields of interest, ”medicine” and ”engineering sciences”, within the framework of CBI A³. But she also found it interesting to look beyond her comfort zone and learned a lot about other areas during this time, such as communication design but also developed personally. In the team, she took on the role of the organizing engineer / researcher. Thanks to her calm and at the same time consistently organized manner and her ability to familiarize herself quickly and in detail with technical issues, she always pushed the project in the right direction. Without her and the time she put in, a raw mass would not have become a well-thought-out idea.

Manuel did his bachelor degree in Mechatronics. Now he studies Informational Technology. He loves to be creative and to prototype; corresponding to his mechatronic studies he always tries to „clash“ the different disciplines, mechanic, electronic and Information Technology. During his studies, he was heavily involved in digital signal processing and the development of prototypes. The CBI A³ program has given him many insights into the life of an entrepreneur. Just the right program to enter the world of startups. He enriched the teamwork with his inventiveness and many ideas, the organizational part is not his cup of tea, but he could learn a lot thanks to the project. Thanks to his critical attitude towards some technologies, he has made sure to research them in even greater detail. With his technical expertise, he pointed in the right direction regarding new possibilities of technical implementation.

Mariya is in her seventh semester studying communication design at the Mannheim University of Applied Sciences. In her studies, she concentrates on UX/UI and brand design. Within CBI A³, she learned to leave her ”design bubble” and approach ideas from a different perspective. She has enriched her team with her eye for detail. Not only did she visualize things in an appealing way, but she also gave a lot of input and refined both the idea generation and the project. Her critical eye for details and her questioning manner always pointed out the gaps in the idea and at the same time, she always had a good idea to close these gaps. Her ability to present the ideas in a clear and appealing way made it possible to plant our idea into the world.

Together this is Team Clash. The team’s mission is to make the world a little bit healthier by taking the treatment of viral infections to a new level.

3

PROBLEM SPACE

”The emergence of numerous diseases can be explained by the expansion of man into previously untouched nature. Intensive land use, the spread of monocultures or deforestation lead to a loss of biodiversity and change the composition of mammal populations. If the ecosystem is thrown out of balance in this way, infectious diseases can spread more easily.” [3] – Dr. Sandra Junglen, Institute of Virology Charité – University Medicine Berlin

Did you know that viral infectious diseases remain one of the leading causes of death worldwide? The main reasons for this are the poor socio-economic and hygienic conditions and the often inadequate medical care in developing countries. [4][5][6]

But what are viral infectious diseases at all?
Viruses can cause harmless illnesses such as a cold or lip herpes. Most of the gastrointestinal infections are also caused by viruses. But viruses as well cause serious diseases such as AIDS, pneumonia, or hepatitis. [7]

Every new virus we find could be a previously unknown cause of disease

New viruses that cause diseases often originate from animals. Well-known examples are the Zika virus from mosquitoes, the avian flu virus, and the camel-associated MERS virus. And every year numerous new viruses are discovered, but also viruses are known to us mutate and become unknown again through the gene shift. [8][9]
”Every new virus we find could be a previously unknown cause of disease, both in humans and in farm animals,” explains Prof. Christian Drosten, Director of the Institute of Virology at the Charité Mitte Campus [10].

But how does the treatment of viral infections look like? Unlike a bacterial infectious disease, antibiotics cannot be taken to treat viruses. Usually, only symptomatic treatment remains [11]. However, one can be vaccinated against some viral infectious diseases. But, there is often no vaccination available for new types of viruses and they, therefore, have to be developed first. To produce an effective and safe vaccine against a new virus usually takes many years, sometimes even decades. In any case too long if an outbreak such as the Corona pandemic in 2020 kills many people within a very short time.

In the industrialized countries, many infectious diseases were reduced and excluded as a cause of death in the course of the 20th century through improved general living conditions and hygiene as well as medical progress. One prominent example is the successful fight against diphtheria through a high vaccination rate, especially in childhood. For some decades now, however, communicable diseases have also been of greater importance for the incidence of disease in industrialized countries, which is due among other things to changes in society, technology, and the environment favours

Health systems are not protected against new viruses

the further development and spread of pathogens. In addition to already known diseases, new types of diseases are gaining in importance, which often appears in industrialized countries only after a time lag. [1]
However, as can be seen from the current situation of the corona pandemic, even industrialized countries with well-developed and well-functioning health systems are not protected against new viruses. Since December 2019, the coronavirus has been spreading almost furiously around the world. The pandemic not only brings us the fear of infection, no, it also has a great impact on our daily life. In many countries, there are exit restrictions, distance rules, and a mouth and nose protection obligation. These are all things we could not have imagined just a few months ago.

But which factors were actually responsible for the rapid spread? Global epidemics – pandemics – are only made possible by the travel patterns of modern people [9]. Although most of us only travel short distances, the few who travel far can spread pathogens worldwide in a very short time. But climate change is a factor for the spread as well. Due to global warming, the transmitting mosquitoes will spread their habitat further and further north, reaching parts of Europe and other regions [12][13]. According to the WHO, over 2 billion people could be infected with dengue fever by 2080 [14]. And then significantly more people will be directly affected. Additionally, global warming has caused many bird species, which are often carriers of viruses, to change their flight paths and stop further north [15]. These, in turn, then meet other conspecifics and this can result in mixtures and also new dangerous virus species for humans. All this will continue to encourage the occurrence and spread of viral infectious diseases in the future as well.

In summary, the question is: How can we prevent the rapid spread of viral infectious diseases and make treatment more sustainable in the future?

4

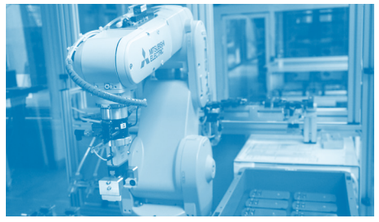
FUTURE SCENARIO

Within the CBI A³ program, we design for the future. For this reason, it makes sense to look into the future, doesn't it? We have divided our vision of the future into individual areas, such as political, environmental and legal. In the following sections, you will get an insight into the individual areas and how they will change until the year 2030.

Political

Until 2030 there will be no other form of government developed in Germany; we will still be a parliamentary federal republic. However, we assume that populist tendencies will increase significantly in both directions. Accordingly, the political centre will continue to shrink [16].

Economical



Environmental, technological and social-cultural changes mean that the economy needs to adapt. Increased automation and digitalization will lead to job losses. The remaining positions will be filled by specialists. Climatic changes will cause a shortage of resources, which will make alternative energy sources necessary [17][18]. The extraction of raw materials will also play a less important role. Last not least, agriculture and the eating habits of the population will have to adapt. Unless the industry continues to adapt to flexible working methods, new, more dynamic industries will play a greater role [19].

Sociocultural

Cimate change is leading to overpopulation. There will be more older people and it will become more difficult for the younger generation to find the financial means to care for them. The gap between rich and poor will widen considerably [24]. We can also imagine that we will become even more of a meritocracy, in which the individual strives for his well-being. A multicultural society with a great variety of languages will be developed even stronger [25].

Technological

The focus will be on increasing digital and automated processes. Conventional technologies will become redundant or will be replaced by more efficient processes. In everyday life, we will use more digital solutions. Many simple activities will be taken over by highly flexible automated assistants. Energy supply is becoming more and more decentralized as supply networks become unstable due to environmental influences.

Legal

We also assume that there will be no major fundamental changes in the legal sense. The law is one of the most enduring things in our society. We can imagine that there could be changes in freedom of speech, as people interpret and apply it differently, blurring the line between freedom of expression in the strict sense and insults/verbal attacks. We could also imagine more European regulations would come into force.

Environmental

The effects of climate change will increase and become much more tangible. In Germany, temperatures will rise and lead to more heat deaths. The European climate will, therefore, be determined by dry periods and droughts [20]. This will lead to food and water crises. It will also result in more and more areas becoming infertile, partly because of the monocultures practised and the exploitation of soil and water resources. The rising temperatures will cause a shift in the world population and we will have to prepare for a large number of climate refugees [21][22]. North of the equator there will be overpopulation. But this population increase must cope with a smaller area. Climate change will also shift the borderline of tropical diseases such as malaria towards Europe [23]. We will see a sharp decline in biodiversity due to deforestation, extreme weather conditions and new pathogens caused by migration of species from other ecosystems.

5

DESIGN SOLUTION

ComImmunity can best be compared to an anti-virus scanner for the computer – just for your body. In short: viruses are detected and destroyed. The whole system consists of three main components. The first component is an AI-powered database and the brain of the system. It stores various virus and antibody data. The heart of the system is the personal biomedical hardware device. It makes it possible to detect and even eliminate viruses. A part of the hardware device is a little helper for the body: the Nanobot. It can best be compared to a sniffer dog as it is searching through the body for virus hotspots and also for immune reactions. The third component of the system is the heatmap and can be described as the system's eye because it makes infected places visible. It visually shows the connections between virus outbreaks and locations.

5.1
USER GROUP

Our main user group consists of people who belong to the risk group for viral infections. The following groups are particularly at risk [26][27][28]:

- Elderly people whose immune systems are no longer functioning optimally due to old age;
- People in nursing homes, because pathogens can spread particularly well there;
- People of all ages with certain chronic illnesses such as chronic kidney disease, anaemia, diabetes, and other metabolic diseases, cardiovascular diseases, for example, coronary heart disease, high blood pressure (hypertension) or heart failure, diseases of the respiratory organs such as asthma, chronic bronchitis, emphysema, chronic obstructive pulmonary disease (COPD) or cystic fibrosis;
- Infants and toddlers, because their immune system is not yet fully developed;
- People with weakened immune systems. This can be congenital, but also the result of treatment or infection. Congenital immune defects are, for example, severe forms of antibody deficiency such as gammaglobulin or hypogammaglobulinemia. The immune system is impaired in people with cancer after chemo- or radiotherapy, HIV infection, and certain drugs that suppress an immune response, for example after organ transplantation.

Risk groups also include people who have a lot of contact with other people in their daily lives. These are, for example, doctors and nurses, employees in department stores and supermarkets, at the post office, the police or at public authorities and transport companies. They can more easily become infected with viruses. [26][27][28]

These people need special protection and for this reason, they are the main user group of ComImmunity. ComImmunity will enable their bodies to fight the viral infection by enhancing their natural immune response.

In addition to this group, it is also important for the implementation of ComImmunity to have a second user group. This user group is made up of people without any previous illnesses and therefore with a stronger immune system. This user group is needed because it can be assumed that their immune system can react quickly and reliably in case of a viral infection. The resulting information about the appropriate antibodies can then be used to help the high-risk groups. However, this user group is not only a means to an end. No, this group can of course also benefit from the ComImmunity system, because it can always happen that their bodies are not able to form the right immune response either. If this happens, they as well can get help from others.

5.2
IMMUNE SYSTEM

The body's immune system protects people from pathogens and foreign substances, but also their altered cells. A distinction is made between an unspecific and a specific defence. The non-specific defence is innate. It is responsible for the non-targeted initial use against pathogens or foreign substances. The acquired or specific defence reacts with a delay. It recognises certain foreign structures (antigens) of pathogens or foreign substances and forms precisely fitting, specific defence molecules (antibodies) to eliminate these antigens. The basis of this targeted procedure is the T- and B-lymphocytes and their antibodies, which fit the antigens accurately. T-helper cells recognise the antigen of an antigen-presenting cell with their T-cell receptor and are activated. The activated T-helper cells multiply and release various cytokines that stimulate the defence cells. B-lymphocytes are mainly stimulated by activated, matching T-helper cells. The stimulated B-lymphocytes then multiply in the secondary follicles of the lymphatic organs and hot centroblasts. The centroblasts differentiate into plasma cell stages and leave the lymphatic organs again to reach the connective tissue of the different organs via the lymphatic and blood vessels. Here they differentiate into plasma cells. Those do not return to the bloodstream but release antibodies. The antibodies enter the blood and other body fluids and therefore provide the body with immune protection against the antigen in question. The antibodies form an antigen-antibody complex with the corresponding antigen, which is phagocyted and broken down by macrophages. [29][30][31]

5.3
DATABASE

We are fortunate to live in a time where scientists all over the world share their research

The database is a special kind of network database. A network database consists of data records which consist of different fields. A field has a name and a value. Each record describes a person, an object, or an event. In this way, disease information and suitable antibody composition can be well filed. [32][33][34]

To get an initial basis for the database, we use existing antibody databases like the Bionity.COM database. It offers over 48,000 different antibodies. [35]

These data sets enable us to help people right from the start of the market launch. This is because the data on antibodies and diseases collected in the past gives patients direct access to a large number of solutions and they do not have to wait until someone suffers from the same disease and provides antibody information to the database. So why shouldn't we benefit from the research of the last decades? "We are fortunate to live in a time where scientists all over the world share their research." – Jacob Glanville (DistributedBio) [36]

It is precisely this statement that we take as our model and think that not only the present but also the future will rely on this exchange. To make our system more adaptable, efficient and correct, we use a technique called Superhuman 3.0, an antibody library from DistributedBio, in addition to the existing antibody data sets. The SuperHuman library allows for cross-species coverage, developability profiles for thermostability, aggregation potential, and immunogenicity [37].

Curing any kind of viral disease naturally

We would like to use this technology because every human being is individual and therefore also forms individual antibodies. Superhuman 3.0 generates over 5000 unique hits against every antigen in our database [38]. This not only makes it possible to individualize existing antibody information from one person to another. Our system also can grow and become more intelligent. In combination with the Tumbler Technology of DistributedBio, it is also possible to generate antibodies if no antibody solution is available in the database yet. Using artificial intelligence Tumbler develops the structure of the required antibody to bind to the antigen [39].

The big advantage is that our system is capable of curing any kind of viral disease naturally because an antibody can be developed at any time, even if none of the patients has provided antibody information to the system. Since the Superhuman 3.0 and Tumbler technologies can work not only with viruses but with any kind of pathogen, there is nothing to prevent the possibility of extending the system to other diseases at a later stage.

5.4
HARDWARE DEVICE

The design of the ComImmunity hardware device will not significantly vary from the design of a standard diabetes sensor. This has the following reasons. Firstly, it is removable, so that the user can remove the device at any time, thus maintaining self-determination, because what must not be forgotten – ComImmunity is voluntary. But it also offers the possibility of easier servicing. However, by allowing users to remove the device and reinsert it at a later date, we must also guarantee the sterility of the product, as it is, after all, a medical device that is inserted into the bloodstream. For this reason, we supply an application device with integrated sterilization with a diode laser that has been specially developed for the disinfection of medical silicone. It is guaranteed that the material of the hardware device is not damaged in any way. In this respect, the ComImmunity hardware device is different from diabetes sensors, which are not reusable and must be replaced after 14 days [39]. However, this is also because attaching the device causes skin irritation, which means that the position must be changed after about 14 days [39][40]. The disinfection makes ComImmunity sustainable. We solve the problem of skin irritation with a plaster layer of hypoallergenic, moisturizing and collagen-containing silicone [41]. This prevents the skin under the sensor from drying out and provides it with sufficient moisture. Besides, the material does not pose any danger for allergy sufferers and users with sensitive skin [41][42][43]. A further advantage of our product is the freely selectable puncture site. Our device can be used on the arm, thigh, back, stomach, and armpit. Further details can be taken from the map for puncture sites (Fig. 1).

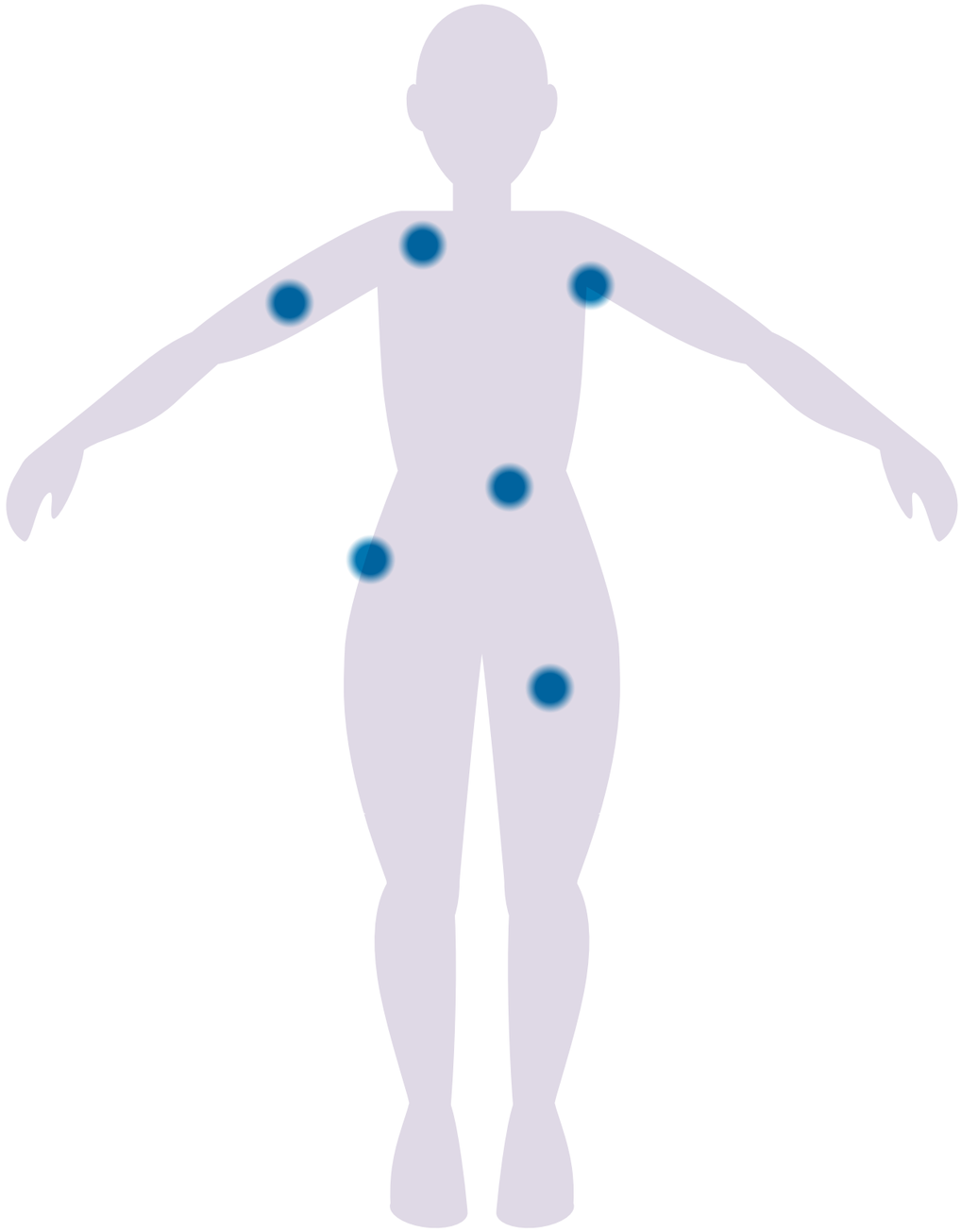


Fig. 1: Puncture site map

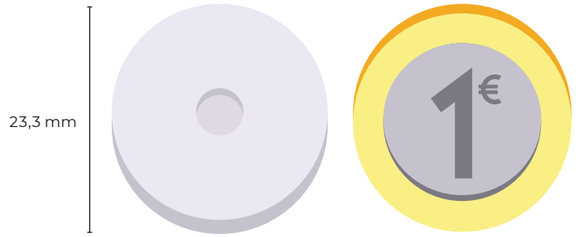


Fig. 2: Hardware device compared to 1€-coin

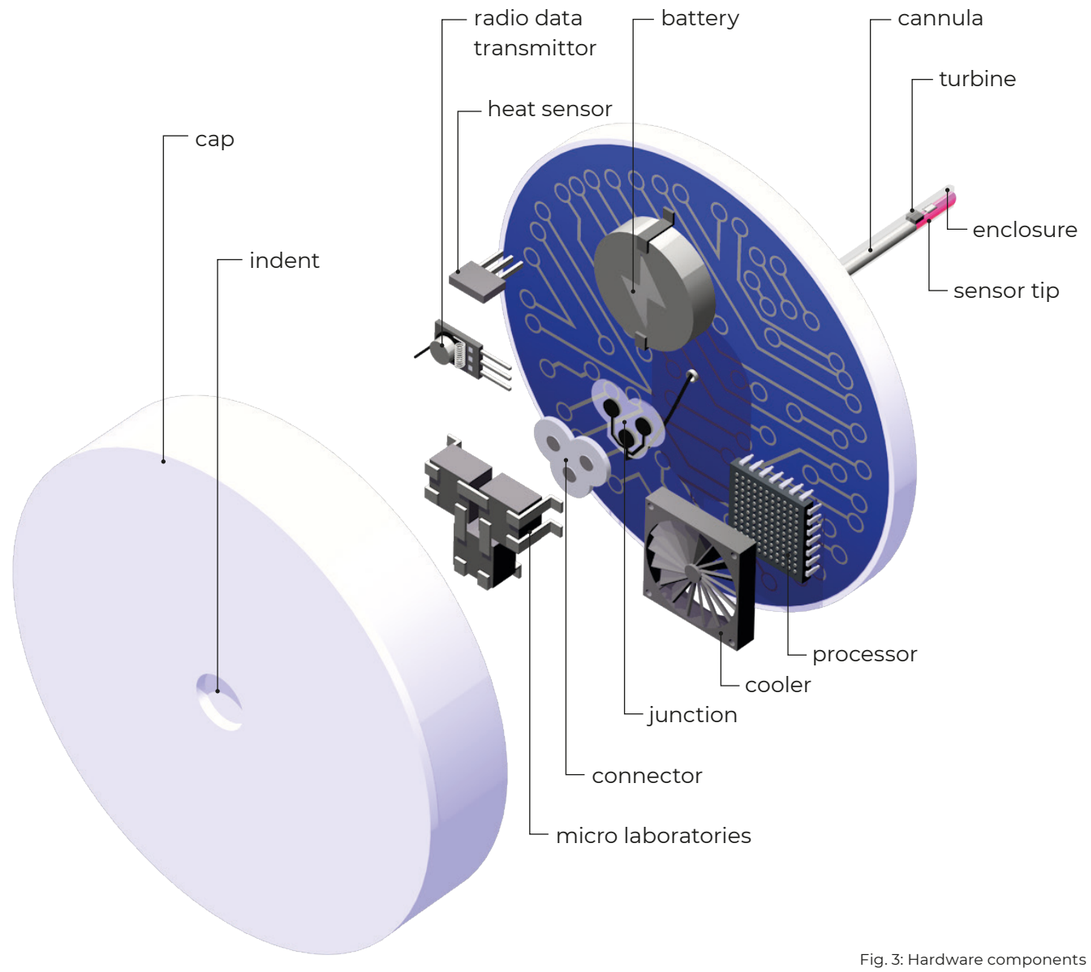


Fig. 3: Hardware components

As already mentioned our hardware device is similar to the diabetes sensors. In terms of size it is slightly smaller, about the size of a 1 Euro coin (Fig. 2). Our device (Fig. 3) has a hollow needle that ends in a circular shape. This shape houses the technology of our system. It consists of three laboratories. One contains the technology for virus analysation, another contains the technology for antibody analysation and the third contains the technology to modify B Cells. Also, the chip contains the antennas for transmission and reception, as well as the battery supply, temperature sensor, and cooling system. The hollow needle has a junction at the end of the chip which allows direct access to the respective chambers via the contacts for the three junctions. At the other end of the needle are the sensors for the detection of an outbreak of a disease. The hollow needle also serves as a transport lock for the nanobot, because the needle and the nodes allow the nanobots to leave and enter the sensor.

As energy supply, we use the so-called Energy Harvesting. This is a system that extracts energy from its immediate surroundings. The energy is produced where it is consumed and only needs to be stored for a short time. Energy sources for the miniature power plants are ambient temperature, movements, vibrations or, which are converted into electrical energy by micro-generators. In our case, a small turbine would be at the end of our needle. The flow movement provides sufficient energy. [44][45][46]
For data transmission, we have decided to use data transmission by radio. This enables higher transmission distances and frequencies. The MICS band (Medical Implant Communication Service) would be a suitable frequency band. It offers a bit rate of up to 800 kBit/s. [47]

The following requirements apply when encapsulating the implant.

1. biostability,
2. biocompatibility,
3. hermetic sealing,
4. guarantee of function.

A biocompatible cellulose encapsulation with a three-dimensional microstructure might be suitable for the capsules. Connective tissue forms on this surface and the function of the implant is not affected because the implant is not encapsulated by the body. [48][49][50]

The whole system will run unnoticed, the person will not feel the hardware device and will not be affected in any way. ComImmunity will become part of our immune system and we will not actively perceive it.

5.4.1
BIOSENSORS

Three biosensors are attached to the hollow needle of the biomedical hardware device and the nanobot. These biosensors detect changes in temperature, C-reactive protein (CRP) and extracellular water content. These three values indicate the presence of a viral disease.

The brain contains a ”heat regulation centre”, the so-called hypothalamus, a part of the diencephalon. It ensures that a largely constant temperature is maintained in the brain, heart, kidneys, and liver by controlling the production and release of heat as required. This temperature set point is set at around 37°C. In the event of an infection or other inflammation, this setpoint is adjusted and is higher than the normal 37°C. [51][52][53][54][55][56]

CRP is a protein that increases the level in the blood in the case of infections, inflammations, but also tissue damage. CRP is not specific for a certain disease. However, the level of CRP increase allows conclusions about the severity of the underlying disease. [51][52][56][57][58][59]

The extracellular water flows around the cells. It is also responsible for ensuring that our cells are adequately supplied. This means that every substance needs water in the canal system to reach the cells or to be released from them. Water is, so to speak, the local means of transport for substances to get from A to B. Without water the cells would not be able to survive. They would starve to death from nutrient deficiency. Elevated extracellular levels usually indicate an infection. [51][52]

Biosensors are measuring probes that contain biological components. According to the definition of IUPAC, biosensors are devices with a stationary biological component (bioreceptor) that convert specific biochemical reactions of an analyte with the bioreceptor into a mostly optical or electrical measurement signal and thus provide qualitative and quantitative detection. A biosensor mainly consists of four parts. The first part is the bioreceptor, which is a membrane on which enzymes, organelles or antibodies are immobilized. This is followed by the transductor, the amplifier, and the detector. When binding to a certain analyte, the bioreceptor changes its physicochemical properties (e.g. pH value, redox potential or temperature). The transducer detects these changes and converts them into an electrical signal that is amplified and thus becomes measurable. A detector now processes this signal and displays the corresponding measured value. Implantable biosensors are an important class of biosensors because of their ability to provide continuous data on the levels of a target analyte; this enables trends and changes in analyte levels over time to be monitored without any need for intervention from either the patient or clinician. As such, implantable biosensors have great potential in the diagnosis, monitoring, management, and treatment of a variety of disease conditions.

Electrochemical biosensors have the potential to offer the sensitive and rapid detection of a wide range of biomarkers; their relative fabrication simplicity, amenability to miniaturization, along with the reduced cost of instrumentation, has also furthered interest in their development. Biotelemetry (the remote measurement of an activity, function or condition) utilizes implantable technology as a means of obtaining data in an experimental setting in conscious, unrestrained animals. Electromyogram (EMG), electroencephalogram (EEG), electrocardiogram (ECG), heart rate, blood pressure, body temperature, activity, and circadian rhythm data can be collected using biotelemetry techniques. [59]

Besides, values such as blood pressure, pulse and peripheral capillary oxygen saturation values are also measured using innovative flexible, biocompatible sensors made of nanocellulose that are integrated in the plaster and lie on the skin. Nanocellulose is an inexpensive, renewable raw material, which is obtained in the form of crystals and fibres, for example from wood. However, the original appearance of a tree no longer has anything to do with the gelatinous substance that can consist of nanocrystalline cellulose and cellulose nanofibres. Thus, nanocellulose is not only comparatively easy and sustainable to extract. Its mechanical properties also make the ”super pudding” interesting, which is why new composite materials can be developed with nanocellulose. They could be used as surface coatings, everyday objects such as beverage bottles or in the form of transparent packaging films. Another important feature of cellulose is that it is biocompatible. To produce sensors that can measure important blood values, the researchers used nanocellulose as an ”ink” in a 3D printing process. To make the sensors electrically conductive, silver nanowires were added to this ink. The scientists determined the exact ratio of nanocellulose and silver threads so that a thrwee-dimensional network could be formed from them. Cellulose sensors can measure medically relevant metabolic parameters such as the concentration of calcium, potassium and nitrogenous ammonium ions. For the measured values to be further analyzed, the electrochemical skin sensor sends its results to a computer for further data processing. In total, the tiny biochemistry laboratory on the skin is only half a millimetre thick. [60]

5.4.2
VIRUS AND ANTIBODY ANALYSIS

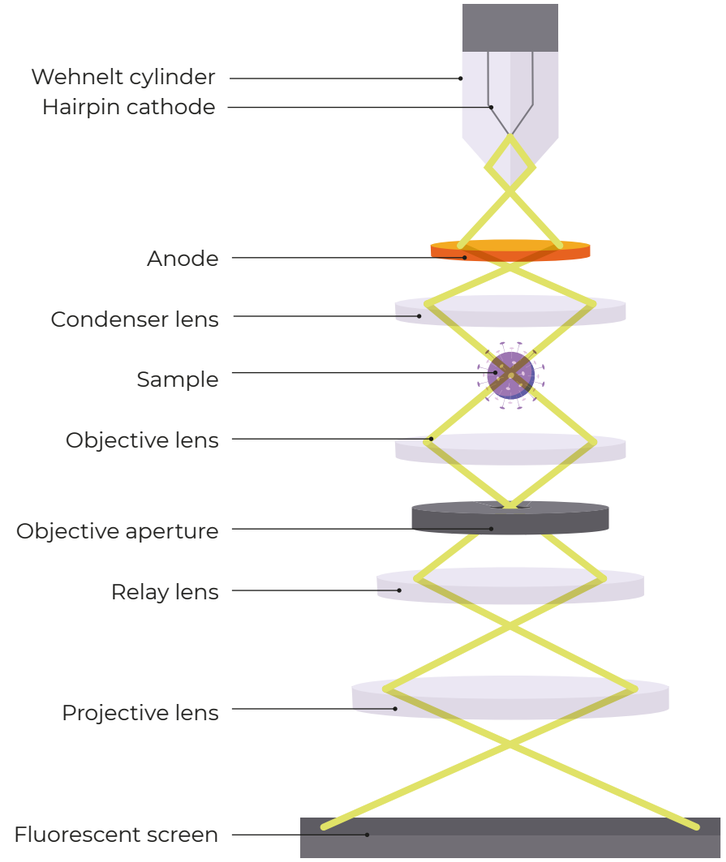


Fig. 4: TEM components

Electron microscopy is the method of choice for making viruses visible. In routine diagnostics, the transmission electron microscope (TEM) is preferably used. TEM is the only imaging technique allowing the direct visualization of viruses, due to its nanometer-scale resolution [61]. It enables the recognition of characteristic structures of viruses, which allows the attribution to a certain virus family or even to a virus genus according to the taxonomy of viruses. The last twenty years have shown the advantage of this method in special circumstances, as its ”catch-all nature” allows diagnosis by visualizing the virus without the need to make assumptions about the pathogen sought. For example, TEM provided the answer in several major outbreaks where molecular techniques could not identify the pathogen.

The structure of the TEM (Fig. 4) is similar to a light microscope, i.e. it consists of enlarging objectives connected in series. The TEM generates a transmitted light electron image with a magnification of 100 to 500,000 times and a resolution of about 0.2 nm. In this way, the different layers of, for example, a layered silicate can be imaged. Afterwards, the image passes the condenser lenses through which the electron beam is compressed and projected onto the sample plane. Finally, the magnification of the final image in the TEM is the product of the magnifications of all magnifying lenses, namely the objective lens, the diffractive lens, the intermediate lens and the projective lens. Transmission electron microscopes are used, for example, in medicine to identify viruses and bacteria and in biology to visualize cell structures (DNA). [62][63]

We also want to use this technology for virus detection in our hardware. However, in a much smaller version (millimetre range). This makes it possible to detect the virus structure. The collected data will have the same format as the data in the database and can be stored unchanged in it.

For antibody detection, we use the same technology as for virus detection – TEM. Just as with viruses, the molecular structure of the antibodies is detected and can be stored unmodified in the database.

5.4.3
B CELL MODIFICATION

The army of antibodies to fight viruses is produced by B cells. Here we want to intervene and support the body with ComImmunity.
B cells work according to the lock-and-key principle. They have surface markers, a kind of sensor with which they recognise structures foreign to the body. Approximately 10^9 – 10^{10} different B cells are in the human body. Each cell uses its surface markers to detect a different intruder. When a viral structure is recognised by a B cell, it begins to produce B plasma cells, which in turn produce the corresponding antibodies. These antibodies bind foreign structures to each other and render them harmless. [64]

Here follows the actual step of the immune reaction with ComImmunity. Normally, during the natural development of a B cell, the recognition sites are assembled as a random selection from various available DNA segments [64].
With ComImmunity, the DNA sections of the B cells are assembled in such a way that they produce antibodies that are compatible with the viruses. The information about the matching gene code is obtained from the antibody database. The data used is taken from other ComImmunity wearers that have already shown a successful immune response against the virus. CRISPR is used to adapt the DNA of B cells to the virus [65].

But what is CRISPR?
CRISPR/Cas9 is a new molecular biological method for cutting and subsequently modifying DNA. In this way, individual genes or – more precisely – DNA building blocks are rewritten or ”edited” [66].

The CRISPR gene-editing technique makes it possible to adapt the B cell DNA.
CRISPR works roughly in three steps [65][66]:

- Finding the target sequence: The CRISPR system uses the RNA embedded in it to recognize the target, a specific DNA sequence that needs to be ”rewritten”.
- Cutting: The Cas9 protein coupled to the CRISPR section cuts the DNA double-strand exactly at the predetermined position in the genome.
- Repairing: Now the cell’s repair systems go into action and reassemble the separated DNA strand. A new gene segment or a new, slightly modified variant of a short DNA sequence (mutation) is inserted in the breakpoint.

After the B cells have been modified in this way, they are now able to recognise the virus and are ”activated” so that they are no longer dependent on T cells, which are normally necessary to activate the B cells. The modified cells are multiplied in the lymphatic organs of the body and thus form a sufficient defence against the virus. This process is already being researched in vitro to combat HIV [67].

5.4.4
NANOBOT

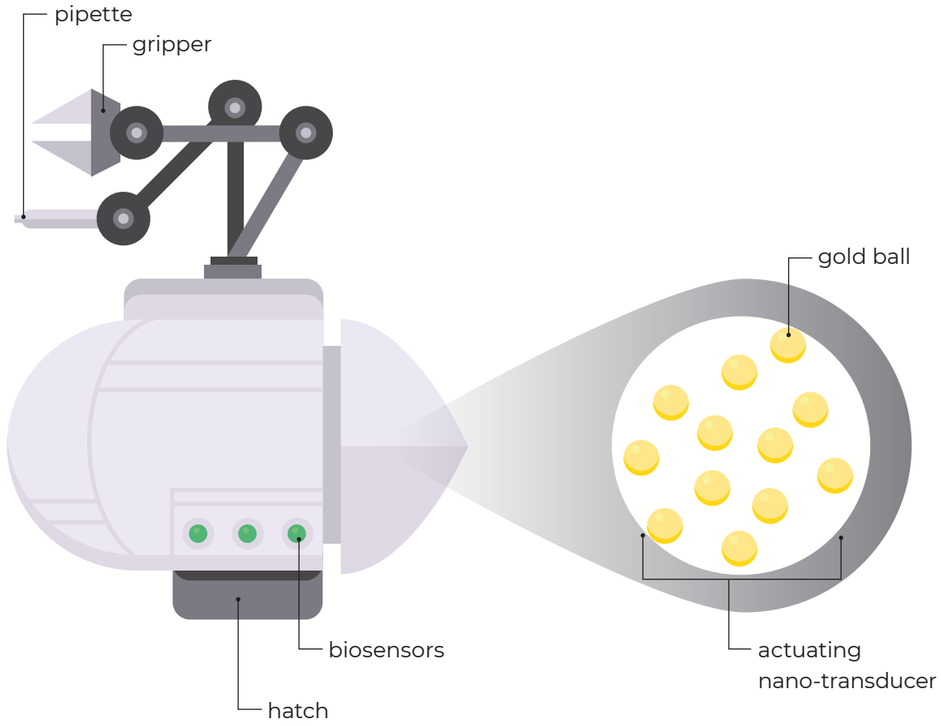


Fig. 5: Nanobot

Nanobots are understood as autonomous machines (robots) or molecular machines in a miniature format as one of the development directions of nanotechnology. Does that sound like science fiction? Probably. We want to integrate nanobots into our ComImmunity system. For what purpose? We want to use a nanobot as the system's helping hand. It will enter the body to detect the centre of the disease and deliver samples to the laboratory in the chip. And will that be possible? Research is already in progress on nanobots for use in medicine, and prototypes have already been developed [68].Consultations with experts have also shown that it is quite realistic to develop nanobots for our purposes.

According to project leader Professor Jeremy Baumberg of the University of Cambridge, nano-Drives are incredibly powerful: concerning their weight, they perform a hundred times better than anything that conventional motors or even muscles can do. The prototype of the microminiaturized drive developed in Cambridge is called "ant", which stands for "actuating nano-transducer". But the ant was also the godfather, after all, it too develops enormous forces when transporting loads. The motor consists of microscopically small gold balls that are embedded in a special polymer gel. Above a so-called critical temperature, gold and polymer are intramolecularly bonded to each other. If the temperature falls below the specified critical limit, the polymer suddenly absorbs water from its surroundings, thereby expanding and pushing the gold balls apart. Hundreds of gold balls are repelled in a millionth of a second. This process can be quickly reversed: When the temperature rises to a critical value, the polymer expels the water and attracts the gold balls back into the atmosphere. Depending on the change in the polymer, the critical temperature can be determined. For medical purposes, it could be 37 °C or the body temperature, for example. This should make it possible for fluids such as blood or gastric juices to pass through. [69][70]

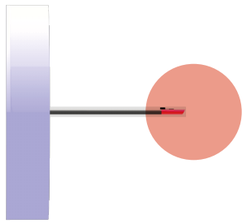
Our nanobot (Fig. 5) will also be equipped with embedded biosensors, which will allow real-time and continuous in-vivo anatomic localization [71].

Additionally, the nanobot will have two arms. The left side will be equipped with a gripper hand. With this, the nanobot is not only able to take for example B cells and virus samples but also cauterize the sampling spot at the same time to prevent any bleeding in the body. On the right side, the nanobots have a pipette, which makes it possible to take blood samples at the viral focus. On the underside of the body is a hatch in which the samples can be stored. After each "drive" automatic disinfection by a cleaning laser takes place. The cleaning laser is formed by a diode laser, as it is also used in dentistry and has a proven disinfecting effect [72]. The shape of the nanobot will be similar to that of a fish. This will allow the nanobot to glide more efficiently and smoothly through fluids.

5.4.5
JOURNEY

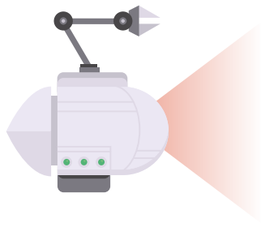
What happens in the body? How are individual technologies linked to each other?

Step 1



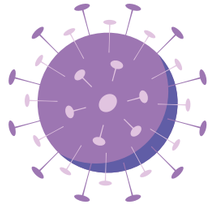
The biosensors on the cannula detect changes in values.

Step 2



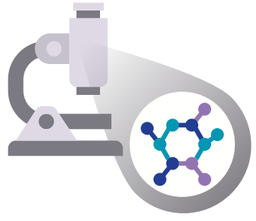
This is the signal for the nanobot to leave the hardware device and start searching for the viral hotspot.

Step 3



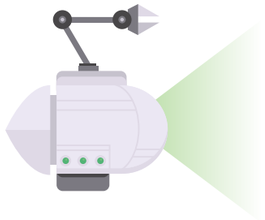
When it has found the hotspot, it takes a blood sample and stores it in its hatch. He drives the sample back to the hardware device.

Step 4



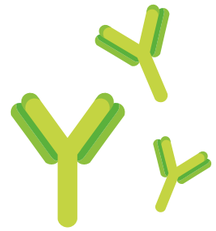
In the virus analysing laboratory, the molecular structure is determined by TEM and made accessible to the database. The databse is then searched to see whether another user has been infected with the same virus.

Step 5

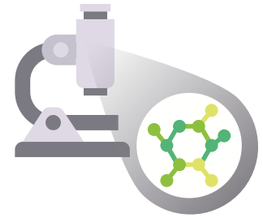


Meanwhile, the nanobot sets off in the body in search of an immune reaction.

Option 1

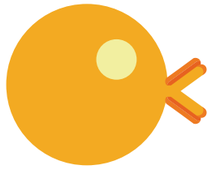


If it finds one, it takes an antibody sample and drives it into the hardware device.

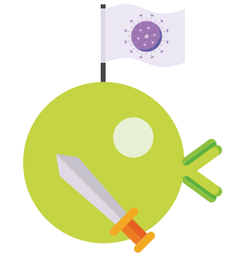


Here it is analyzed in the antibody analysis laboratory and stored in the database. This information can be accessed by other users.

Option 2



If the nanobot does not detect an immune reaction, it takes B cell samples and drives them to the modification lab.



Here the B cells are genetically modified with the help of CRISPR to form the correct antibodies. The information on how to modify the cells is obtained from the antibody data stored in the database. These modified B cells are then transported by the nanobot into the lymphatic system. Here the natural immune response takes over.

5.4.6
APPLICATION DEVICE

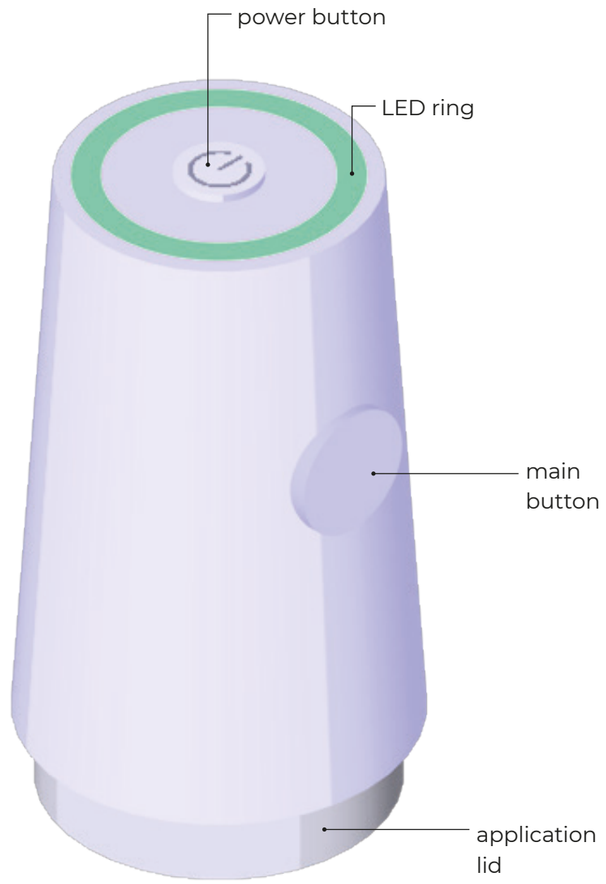
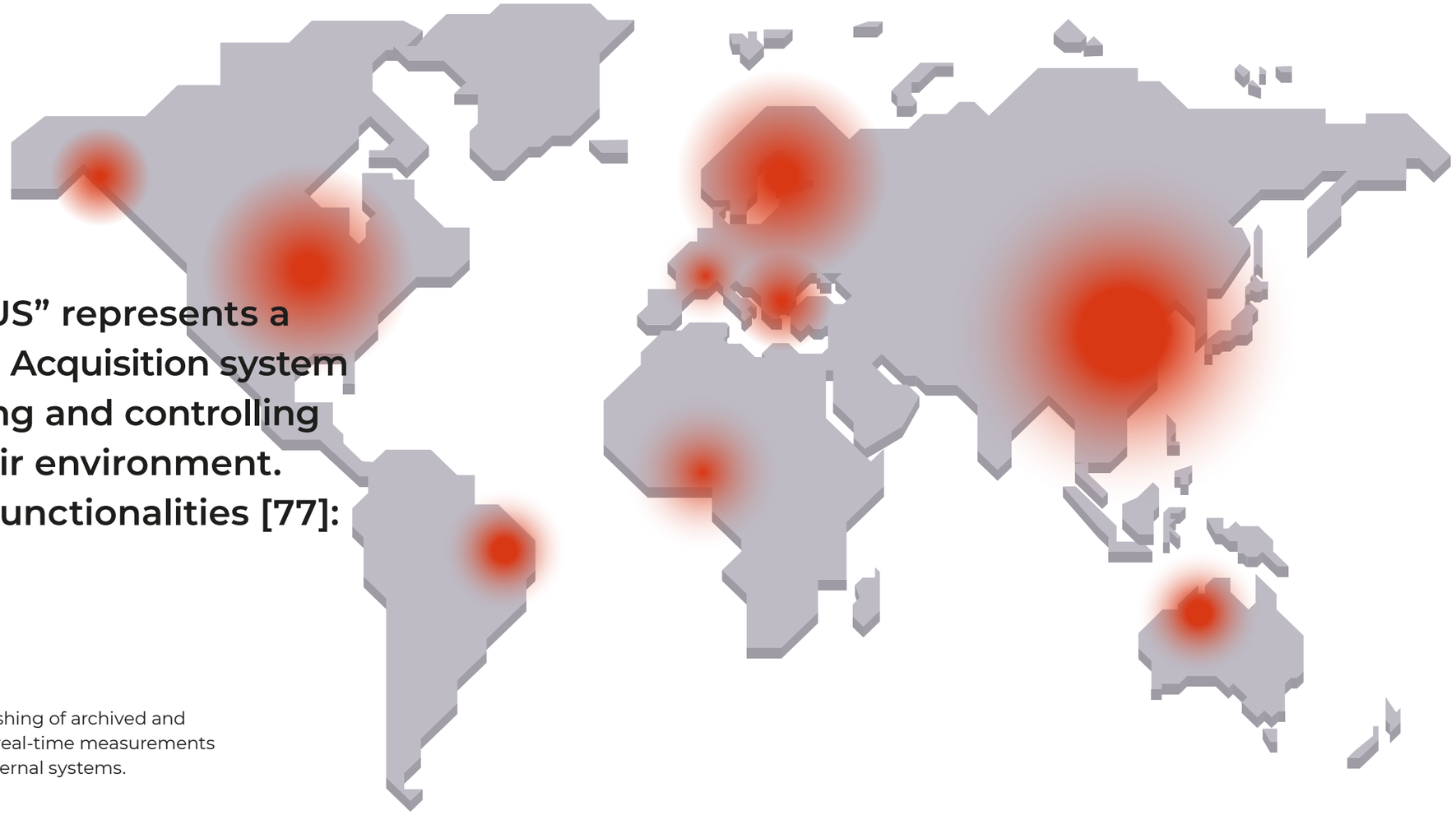


Fig. 6: Application device

The application device (Fig. 6) is used to attach and detach the biomedical hardware to and from the body. The device is large enough to store the hardware device inside. The first time the hardware device is used, it is already stored in the applicator. As a first step, the applicator must be switched on using the On/Off button. To attach the applicator to the body, the ”main” button must be pressed after holding the applicator with skin contact to the spot where you want to attach the biomedical hardware device. When the button is pressed, a lid on the underside of the applicator opens and the hardware device is pushed through the skin by a pressure mechanism. The cannula is then completely enclosed by the tissue so that only the tip with the biosensors is placed in the bloodstream and only the chip with the moisturizing patch is placed onto the skin. Skin contact sensors prevent false triggering [73]. After application, the applicator can be turned off. To remove the biomedical hardware device, the applicator must be switched on again, positioned over the chip and the ”main” button must be pressed. To see if the applicator is placed in the correct position, there is an LED on the top of the applicator which lights up green when the applicator is placed exactly over the chip. This is made possible by integrated ultrasound sensors, similar to a parking aid in a car [74][75][76]. By pressing the button, the lid on the bottom of the applicator opens and the biomedical hardware device is removed from the body by a vacuum mechanism and stored in the applicator. To ensure a clean and sterilized product for the next application, the biomedical hardware device is cleaned by an integrated diode laser [72]. It is ensured that the device is not damaged by the sterilization.

5.5
HEATMAP



The CERN technology ”REMUS” represents a Supervision, Control and Data Acquisition system (SCADA) capable of monitoring and controlling organizations’ impact on their environment. REMUS offers the following functionalities [77]:

- Data acquisition and archiving of measurements and events coming from the instrumentation.
- Display of near real-time measurements, alarms and operational states of instrumentation through customizable user interfaces composed of synoptic, widgets and alarm screens.
- Remote the sending of commands and operational parameters to the instrumentation.
- Display of archived and near-real-time measurements and events coming from the instrumentation, through a data visualization tool, ERGO (Environment and Radiation Graphic Observer).
- Publishing of archived and near real-time measurements to external systems.
- Run-time installation of new instrumentation.

Through REMUS ComImmunity becomes a global health monitoring system. Within the framework of ComImmunity, we would like to use REMUS for the geographical monitoring and screening of pathogens. REMUS will be provided with the data of the database and the hardware device to establish schemes and connections between location and life circumstances of the wearer. Thereby we hope to be able to recognize early on when and where a hotspot of disease is located to take appropriate actions if necessary. By giving the authorities the possibility to take appropriate steps if necessary, pandemics and epidemics can be prevented. Take for example the outbreak of the coronavirus in Wuhan at the end of 2019: By including REMUS in ComImmunity it would have been possible to detect the virus hotspot located in Wuhan much earlier and act accordingly (e.g. with quarantine or other suitable methods) and therefore limit the spread of the virus.

REMUS is not only supposed to provide information about hotspots to the authorities and responsible persons but also to its users. In addition to the functions already mentioned, the patients mobile phone interface also provides an early warning system for the user himself. This function is either linked to the positioning service of the respective mobile phone and can thus give the user early warnings if he notices himself in the vicinity of a hotspot or the user can predefine locations for which he wants to receive warnings. It can be compared to the German early warning apps Katwarn or Nina. These apps warn the user if he is in an area where, for example, toxic substances are escaping and tell him how to behave best under the circumstances.

5.6
APP

To allow users to follow how ComImmunity directly affects their health, the ComImmunity app is another part of our system. It also protects against potential abuse and gives users control over their personal information.

Each hardware device has a unique device code that must be used to register the device in the app (Fig. 7). With the successful registration, the user gains access to the application and so to the full potential of ComImmunity. The app is roughly divided into four sections.

The first is the home screen, which is displayed when the app is started (Fig. 8). It displays information about treatment and device status. Regarding the treatment, the user can decide to use ComImmunity to fight the disease or decline it. If a virus is found, information about the virus, its risk for the individual user and the option to start the treatment with ComImmunity is displayed here. The user will receive a push notification if push notifications are enabled. The user gets also notified if the device needs maintenance.

The second section is the heat map (Fig. 9). Depending on whether the user has enabled their location settings, they will be notified if they are near an infected place. Alternatively, the user can search for a location.

Under the ”My Health” tab, the user will find information on all parameters tracked by ComImmunity (Fig. 10). If a change in the parameters or a critical value is detected, the user will receive a notification and visual feedback. The user will also find his or her detailed record of illness.

The last section is the settings where the user can decide which rights the app should have and where he can change his account settings (Fig. 11). Since we want to offer security by design, all rights that are not mandatory for the functionality of ComImmunity, such as location or Bluetooth, are switched off by default.

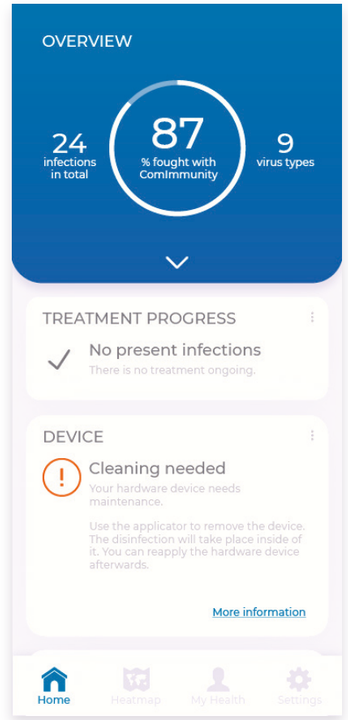


Fig. 8: Home screen

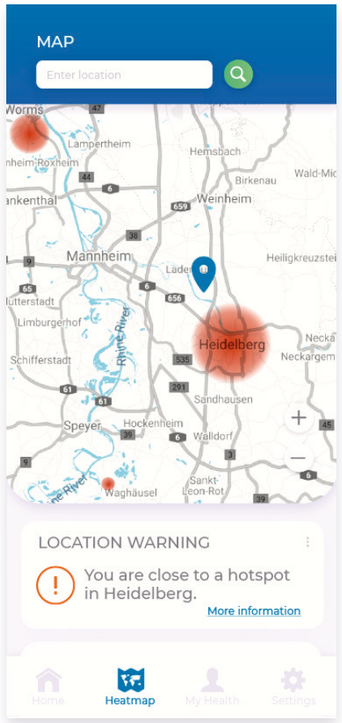


Fig. 9: Heatmap

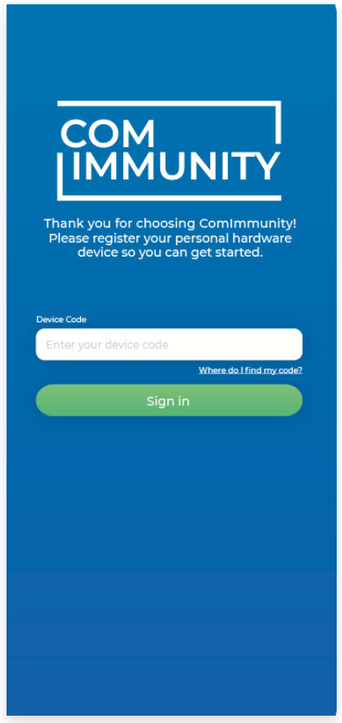


Fig. 7: Registration screen

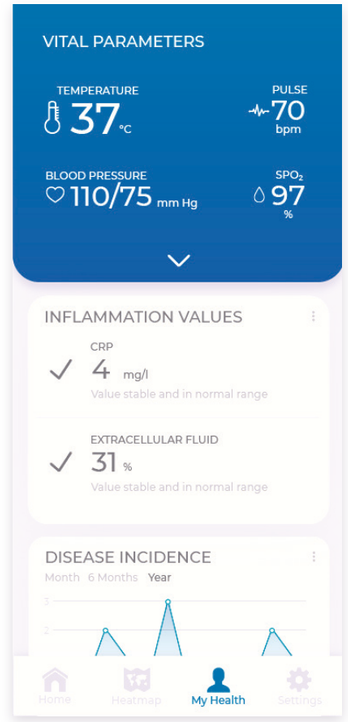


Fig. 10: Patient record

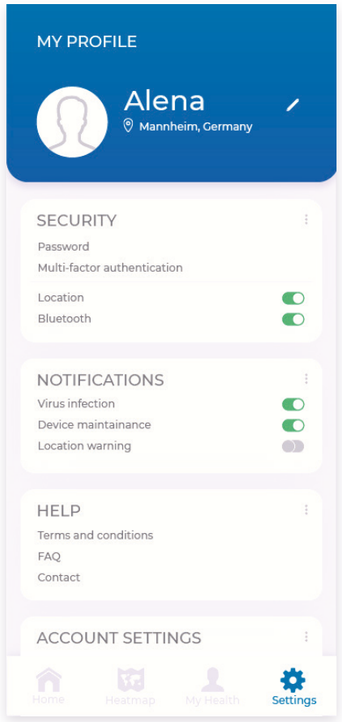


Fig. 11: App and profile settings

5.7
DATASECURITY

Data protection plays a central role in our modern times. It is, therefore, all the more important to deal with this topic in detail. Since health information is one of the special types of personal data, data protection in the health care system requires special attention. In principle, only data that are necessary for treatment should be collected.

High degree of security by avoiding single points of failure

Data protection of the data collected by ComImmunity is carried out according to the highest security standards. This means that a decentralised system is used. The individual connections are not arranged according to a specific scheme, but the individual nodes are connected several times (meshed) [78]. This is intended to make monitoring and illegal use of the data more difficult because it creates a high degree of security by avoiding single points of failure and transparency [79][80]. A suiting possibility could be the use of blockchain technology. It provides the possibility to heighten security by using smart-contract as well as transparency. [81]

Secured by design

Furthermore, we give the users of the ComImmunity the power to decide for themselves whether their data may be stored in the database. Before the data can be saved, this process must first be activated in the settings of the ComImmunity app. The interface is secure by design, meaning that it is self-explanatory so that there is no confusion or uncertainty for users. This gives the user independence in his decision.

There are also various authentication options. The patient can only register in the app with his chip number. Researchers who want to have access to the database must first be verified by their research institute. Doctors also have to make requests in advance to be allowed to view their patients' data. [82][83]

It should also be mentioned that the data is, of course, anonymised [83][84]. The antibody and virus data are stored only as such and not with the patient's name. Furthermore, every information is secured by end-to-end encryption [85]. All transmitted information is encrypted by the sender and only decrypted again at the receiver.

Third parties cannot access the content

Over the entire transmission path, the data is only available in encrypted form. Third parties such as intermediate stations or service providers cannot access the content [86]. For them, only control information is available that allows the encrypted information to be forwarded or routed.

Regarding the heatmap, the user can decide for himself whether he wants to share his location with others or not. Again, a user-friendly interface is designed to avoid any uncertainties and ambiguities.

In implementing all this, we comply with the European directives such as the General Data Protection Regulation (GDPR). The aims of the GDPR are to protect the fundamental rights and freedoms of individuals and in particular their rights to the protection of personal data and the free movement of personal data. [87]

ComImmunity has another special characteristic. Our goal is to operate worldwide, but we will only initiate the licensing process for ComImmunity in countries that fulfil certain criteria. Similar to the Copenhagen criteria for admission to the European Union, we require general institutional stability and democratic and constitutional order. Furthermore, respect for human rights and respect for and protection of minorities in the state concerned must be guaranteed. [88]

An intensive examination of the conditions in the individual countries must first ensure that there will be no unintended use of information by governments. This includes, on the one hand, the use of virus and antibody data to produce biological weapons, but also the transfer of citizens' health data.

6

USER TOUCHPOINTS

In order to explain in more detail how Com-Immunity is handled and the first meeting with ComImmunity, the following describes the view and initial experiences with ComImmunity from the perspective of three different stake-holders.

This is Dr. Martin Baumann

Specialist for internal and general medicine

„The dependence of patients on the doctor decreases, the role of the doctor becomes increasingly passive and consultative.“

Age: 55

Sinus-Mileu: Liberal-Intellectual

Archetype: Hero

BIO

Martin Baumann was born in 1965 as the oldest son of a family of doctors and followed this tradition. He wants to establish a relationship of trust between himself and his patients. At the same time he also wants to be successful and contribute his part to the development of medicine. When not working he is a caring father and family man.

PERSONALITY

Introvert — Extrovert

Traditional — Progressive

Passive — Active

Detailed **Direct**

MOTIVATIONS

Patient welfare | Intensive patient-doctor interaction | Success and appreciation | Concerned about the well-being of his patients.

FRUSTRATIONS

- Restricted therapeutic freedom
- Self diagnosis of patients
- Bureaucracy
- Less time for his family

GOALS

- Success
- Appreciation
- Contribute to medical process
- Family cohesion

First of all from the perspective of a doctor. In today's world, a doctor is quickly frustrated, has little time for his patients and long working days. He hopes that he can still offer his patients good individual treatment, but he also wishes to have fewer working hours and more free time to spend with his family and for hobbies.

This doctor now learns about a new program through ComImmunity sales or the health insurance companies. This program is intended to relieve him or her and offer a novel individual therapy for viral infectious diseases.

At first, he is sceptical, but also very interested. At least ComImmunity could help him with his wishes for better individual treatment and more leisure time. So next he finds out more and talks to his colleagues who have already had experience with ComImmunity. He gets confirmation that it is a trustworthy system and that all colleagues have only positive reports. Now he is even more interested, curious, and as well optimistic.

He then registers for a training course to be able to offer ComImmunity to his patients. After successfully completing the product training, he can start offering ComImmunity to his patients. If a patient shows interest, he will provide him with information material and explain the product in more detail. Afterwards, he is also responsible for the information transfer of the concept and the exact instructions for the patient. After detailed instructions, the doctor puts the first biomedical hardware device on the patient.

After a while, more of his patients use ComImmunity and need fewer appointments for the treatment of viral infectious diseases. This leaves him more time for the rest of his patients and at the same time, he gains more free time. This makes him happy, relieved, and satisfied.

This is Alena Meise

Accountant

„I would like to be more joyful in life and be able to do more - simply not be so dependent on medication and doctors.“

Age: 35

Sinus-Mileu: Middle Class

Archetype: Innocent

BIO

Already at the age of 12 Alena was diagnosed with Morbus Crohn. Altought she has to visit her doctor frequently, she enjoy life as much as possible. She loves to go among people, make new friends and gain new expierence. She wish to not be labelled as „the sick one“ and lead a life withot being dependant on doctors and medication.

PERSONALITY

Introvert — Extrovert

Traditional — Progressive

Passive — Active

Open-minded **Down-to-earth**

MOTIVATIONS

Better quality of life | Mobility | Sociability

FRUSTRATIONS

- Long hospitals visits
- Medication
- Limited mobility
- Isolation
- Chronic pain

GOALS

- Mobility
- Less dependence on doctors and medication
- Painfree
- Comprehension

The second perspective will be that of the actual main user, the person with a previous illness, and thus a member of the risk group. The patient normally has various yearly routine examinations.

This stresses him out, he is annoyed. He often complains about his health situation to his friends. But when his doctor recommends ComImmunity to him he is really interested and hopeful. He likes the perspective of continuous health but is still a bit sceptical because it is not the first time his doctors recommend alternative treatments and they usually didn't help him at all. But after he read the informative brochure and talked with his health insurance company about the costs he is even more excited, curious and determined. He really looks forward to his next doctor's appointment where he gets additional information and instructions on the product.

He finally gets his first hardware device which gets inserted by the doctor. He is excited, hopeful, and feels special and proud in the sense that he now can not just help his own immune system but also the immune system of other people. He feels like a part of a big community. Now he downloads the ComImmunity app and gets an overview of his whole body and his reactions to different types of viruses. He is interested and feels safe for the first time in a while.

When his body is fighting a virus he gets a notification and has the opportunity to decide whether he wants to treat the virus with or without the help of ComImmunity. Before he decides this he reads the additional information about the virus in the app. During this time he is a bit concerned and anxious. He finally decides to fight the virus with the help of ComImmunity, he is hopeful and still a bit sceptical. But when he gets the notification in the app that his body defeated the virus successfully with the help of ComImmunity he is happy, relieved, convinced and feels safe.

This is Prof. Michael Sauer

Molecular Biologist

„I wish the day would have 48 h. There is not enough time and access to research data is sometimes expensive and limited.“

Age: 41

Sinus-Mileu: Performer

Archetype: Sage

BIO

Michael is the second child of a well-off family. He studied Biology and Chemistry and then completed his PhD at a renowned institute. Since then he has been head of the department in the field of microbiology. He lives for his field and researches so intensively that he could be awarded the Nobel Prize.

PERSONALITY

Introvert — Extrovert

Traditional — Progressive

Passive — Active

Determined **Structured**

MOTIVATIONS

Becoming the best at his field | Knowledge | Changing the world

FRUSTRATIONS

- Cuts in research money
- Short research time
- No access to all research data
- Competition

GOALS

- Finding good sources of information
- Financing of independent research
- Sharing knowledge free and globally

The third and last perspective is the one from a researcher in the biomedical field. He is actually demotivated because he is not provided with data from Japan that he urgently needs for his research. He needs licenses for papers and that’s expensive – his research centre has not enough money for everything he needs. He is annoyed, stressed, and angry. At his daily lunch break, he complains about not getting the data he wants.

His colleague then tells him about the global database project ComImmunity. He is quite interested, motivated, and hopeful. He searches for the database and gets informed about the verification he needs to enter the information in the database.

Very optimistic he proposes to his chief and tries to convince him about the database. The chief likes the idea and starts the verification process. Now the researcher gets entrance to the data. He is happy and full of expectation.

7

IMPLEMEN-TATION

Why ComImmunity is needed has already been explained in detail in earlier chapters. The increasing climate change and overpopulation, as well as the threat of further viral pandemics and symptomatic treatment, are significant reasons. However, before ComImmunity can be successfully launched on the market, several intermediate steps must first be taken.

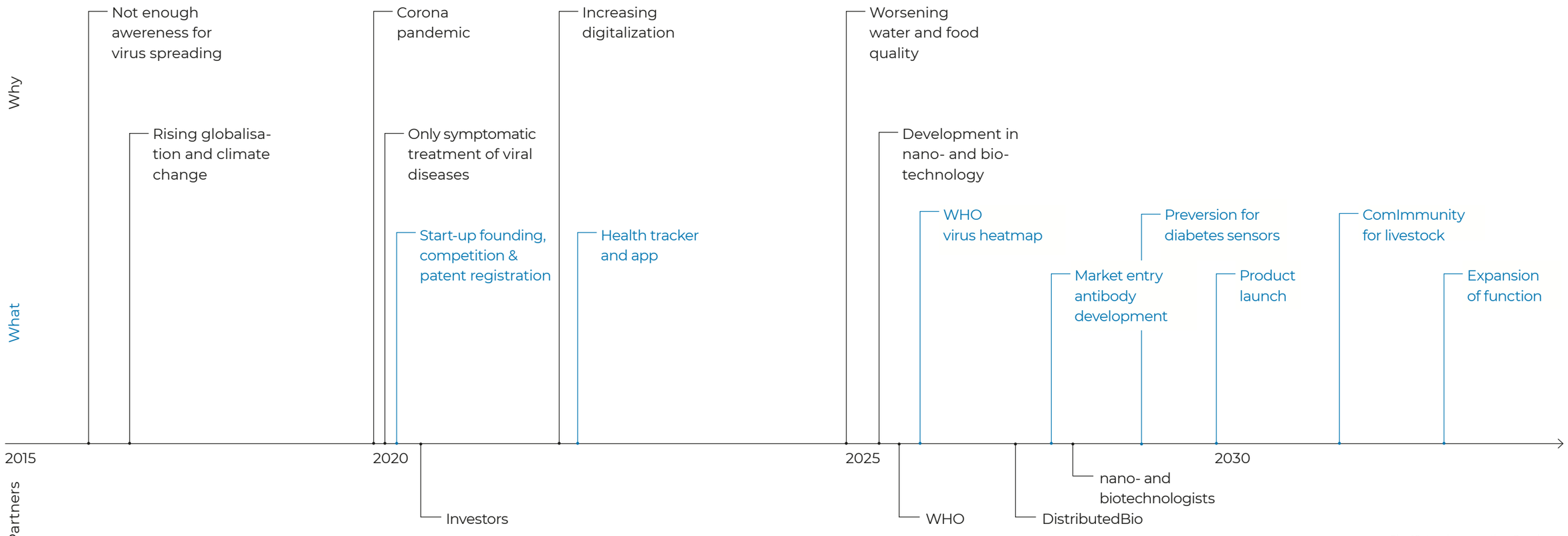


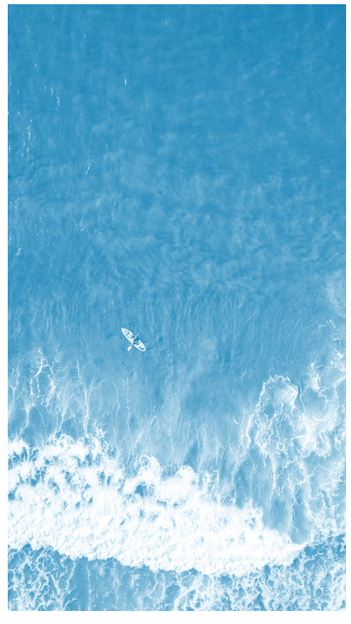
Fig. 12: Implementation Roadmap

What is the best way to get started? Exactly, with a start-up foundation. Parallel to this, a patent application is filed. However, good legal advice is indispensable to master this first step. Since it is difficult to get a large amount of money from investors or partners right at the beginning to develop ComImmunity directly in one piece, we have decided to use a cross-financing method. This means that we develop and launch individual products that will later be part of the overall concept of ComImmunity. We finance further research and development from the profits of these sub-products. The individual sub-products and partners are shown in Fig. 12. Nevertheless, we will participate in global competitions and hope to receive some prize money to kick-start our development journey. We will launch the first sub-product in 2023 – a mobile health monitoring smart device. Similar to today's fitness tracker, biosensors are needed for development. We will bring biologists and software developers on board. The profit from the sale of this product will be used to finance further research. By 2025, digitization will continue to advance, but our water and food quality will also deteriorate. For this reason, we are planning to launch the WHO virus heatmap in 2026. To implement this, it is, of course, necessary to win the WHO as a partner. Furthermore, the CERN technology REMUS will be used for the implementation. This system will be similar to the ComImmunity heatmap, but it will be fed by data from the WHO. After 2025 we expect another big step forward in bio- and nanotechnology, which will open up completely new possibilities. On this basis, we are aiming for the market entry of our antibody development service for medicine and research in 2028. To implement this project, we will win the partner DistributedBio and use their technologies Superhuman 3.0 and Tumbler to realize antibody production. We will then develop nanobots for medicine in 2029. However, this project will require the expertise of nanotechnologists and biotechnologists. By 2030 there will be a discernible shift from tropical diseases to the Northwest. That's why we are now pushing the full gas here. ComImmunity should be on the market before the next pandemic. But first, we will produce a perversion for a diabetes sensor chip and launch it before the end of 2030. Once all the sub-products have been developed, the overall ComImmunity concept is put together from the individual parts and clinical studies and clinical evaluation follow. A marketing plan is also developed. The final step is then only to obtain approval for the European market. Legal counsel will again be consulted on this. As soon as the approval is granted, ComImmunity will be available in Europe. After that, we do not want to exclude the advantages of ComImmunity from the livestock industry. For this reason, we are planning a version for animals and will launch it in 2033. Until 2050 there will also be an updated version, which will not only detect and treat a virus but also bacteria and other pathogens.

8

VALUE

ComImmunity will not only be able to change the lives of a few but the lives of many. Through ComImmunity, high-risk groups will in future be protected from the consequences of viral infectious diseases. But even on a larger scale, the whole of humanity will benefit from Com-Immunity, because even people who are not part of the system will benefit from the data collection.



This is because the collection of data will significantly accelerate research in the biomedical field, which, among other things, will lead to faster development of vaccines. Although it is no longer possible to stop or even prevent overpopulation and the shift in tropical diseases, ComImmunity is able to relieve the burden on healthcare professionals. By removing the treatment of viral infectious diseases from the daily routine of many doctors, they can now concentrate more on caring for other patients and spend more time on each one. At the same time, they also have more free time. Apart from relieving the medical staff, it is also possible to do something good for the environment. During the treatment with ComImmunity, no medication has to be taken. This, in turn, means that fewer medications are produced, prescribed, taken, and disposed of for the symptomatic treatment of viral diseases. As a result, we do not pollute our waters any further and thus also help our flora and fauna.

And even if ComImmunity cannot prevent rising overpopulation and globalization, the system still ensures that the risk of an epidemic or pandemic is kept as low as possible and can be contained in time. By collecting data, patterns that lead to an increased spread can be detected early so that authorities and individuals can take early action to contain the spread of a virus.

With ComImmunity, we want to be able to detect and analyze viruses and antibodies by 2030. It should also be possible to genetically modify B cells. But who says that’s all there is to it? Exactly, it’s almost obvious. The whole system can also be knitted even further and can be an alternative and substitute for any kind of medicine. Why shouldn’t we extend the system to bacteria or allergies in the future? You can do so much with antibodies. Research has shown that antibodies are also used in cancer therapy.

For example, therapeutic antibodies are supposed to release certain ”brakes” in the immune system so that the body’s immune system destroys the tumour. Other antibodies specifically attract immune cells to the tumour, which are then supposed to fight it. Therapeutic antibodies can also block important growth signals of the tumour cells.[89][90]

What if this immune reaction could also be induced via ComImmunity?

Another research suggests that antibodies can also be used in the treatment of strokes to reduce the side effects of lysis treatment and promote recovery. Antibodies have been known for a long time to prevent blood vessels from being blocked by blood platelets in the brain. [91][92][93][94][95]

9

CONCLUSION

ComImmunity takes the treatment of viral infections to a completely new level. It is possible to support the immune system in a way that the fight against the virus is done from the inside without treating the symptoms with medication.

By combining already existing technologies like TEM, CRISPR, and an AI-powered database with a future technology like Nanobots for implementation it is potential to detect, analyze, and modify biological material. With the help of CERN's monitoring system REMUS, we are not only able to fight viruses in a new way but through the processing and visual preparation of the collected data, we are also able to react more quickly and to prevent viral outbreaks at an early stage through appropriate actions.

To implement all this, however, detailed planning is necessary. Besides, sufficient financial start-up aid must be provided. We hope for sufficient attention to attract investors and start the first steps of implementation to kick-start our project. Experts in the fields of microbiology, biotechnology, micro- and nanoelectronics, but also legal experts are needed.

We are in a position to create a future with-out epidemics, without deadly disease courses, and with a reduced drug waste. Humanity can open a new chapter – our future with ComImmunity.

LITERATURE LIST

[1] Greenaway, Christina, and Brian D. Gushulak. "Pandemics, migration and global health security." Handbook on migration and security. Edward Elgar Publishing, 2017.

[2] Design Factory Melbourne, "CBI A³," [Online]. Available: http://cbi.dfm.org.au. [Accessed 15 05 2020].

[3] Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit, „BMU," 02 04 2020. [Online]. Available: https://www.bmu.de/pressemitteilung/schulze-weltweiter-naturschutz-kann-risiko-kuenftiger-seuchen-verringern/. [Zugriff am 14 05 2020].

[4] World Health Organization, "World Health Organization," 2018. [Online]. Available: https://www.who.int/data/gho/data/themes/topics/causes-of-death/GHO/causes-of-death. [Accessed 08 Mai 2020].

[5] W. Hellenbrand, "Gesundheitsberichterstattung des Bundes Heft 18," Robert Koch-Institut, 2003.

[6] Fauci, Anthony S., Nancy A. Touchette, and Gregory K. Folkers. "Emerging infectious diseases: a 10-year perspective from the National Institute of Allergy and Infectious Diseases." International Journal of Risk & Safety in Medicine 17.3, 4 (2005): 157-167.

[7] Howard, Colin R., and Nicola F. Fletcher. "Emerging virus diseases: can we ever expect the unexpected?." Emerging microbes & infections 1.1 (2012): 1-9.

[8] Morse, S. "Factors and determinants of disease emergence." Revue scientifique et technique-Office international des épizooties 23.2 (2004): 443-452.

[9] Wolfe, Nathan D., Claire Panosian Dunavan, and Jared Diamond. "Origins of major human infectious diseases." Nature 447.7142 (2007): 279-283.

[10] Deutsche Zentren der Gesundheitsforschung, "DZIF - dem Deutschen Zentrum für Infektionsforschung," [Online]. Available: https://www.dzif.de/de/entwicklung-von-impfstoffen. [Accessed 19 März 2020].

[11] Hamilton, John D., et al. "A controlled trial of early versus late treatment with zidovudine in symptomatic human immunodeficiency virus infection." New England Journal of Medicine 326.7 (1992): 437-443.

[12] Pike, Jamison, et al. "Economic optimization of a global strategy to address the pandemic threat." Proceedings of the National Academy of Sciences 111.52 (2014): 18519-18523.

[13] Hales, Simon, et al. "Potential effect of population and climate changes on global distribution of dengue fever: an empirical model." The Lancet 360.9336 (2002): 830-834.

[14] Harris, Michael. "A future for planning: Taking responsibility for twenty-first century challenges." Routledge, 2019.

[15] Wormworth, Janice, and Karl Mallon. "Bird species and climate change: The global status report: A synthesis of current scientific understanding of anthropogenic climate change impacts on global bird species now, and projected future effects." Climate Risk Pty Limited, 2006.

[16] Alboth, A., Burmeister, H., Marsilli, L., Omnes, O., & Tsomou, M. "Building Bridges for Social Cohesion". Young Europeans´ Forum 2019 (2019).

[17] Yang, YC Ethan, et al. "Impact of climate change on adaptive management decisions in the face of water scarcity." Journal of Hydrology (2020): 125015.

[18] Hlaba, Aviwe. "Process optimization and environmental assessment of municipal solid waste conversion to liquid fuels and/or chemicals." Diss. Cape Peninsula University of Technology (2020).

[19] SETIAWAN, SYAFRIE BIMA. "Sustainability and the Competitive Advantage: The Perspective of the Logistics Industry." International Journal of Business and Economic Affairs (IJBEA) 4(5) (2019): 201-213.

[20] Drexler, Sophie, et al. "Thünen Report 75." Johann Heinrich von Thünen-Institut (2020).

[21] Villar, Cynthia Desmet, and Laura J. Bishop. "Our Moral Responsibility Towards Climate Refugees." PHIL 127 Climate Change and Global Justice (2020).

[22] Assefa, Kinfe. "The Malthusian Paradigm and COVID – 19: Challenges and Opportunities." Mekelle University Institute of Population Studies (IPoSt) Center for Population and Development (2020).

[23] Bariotakis, M., Sourvinos, G., Castanas, E., & Pirintsos, S. A. "Climatic influences on the worldwide spread of SARS-CoV-2." medRxiv (2020).

[24] Solonets, D. "Gap between the rich and the poor in a modern world." (2020).

[25] de Jong, Julie, et al. "Afterword: Future Directions in Multinational, Multiregional, and Multicultural (3MC) Survey Research." The Essential Role of Language in Survey Research (2020): 243.

[26] Falsey, Ann R., et al. "Respiratory syncytial virus infection in elderly and high-risk adults." New England Journal of Medicine352.17 (2005): 1749-1759.

[27] Brydak, Lidia B., and Magdalena Machala. "Humoral immune response to influenza vaccination in patients from high risk groups." Drugs 60.1 (2000): 35-53.

[28] Joseph, Carol, Yu Togawa, and Nahoko Shindo. "Bacterial and viral infections associated with influenza." Influenza and other respiratory viruses 7 (2013): 105-113.

[29] Berg, Jeremy M., John L. Tymoczko, and Lubert Stryer. "Das Immunsystem." Stryer Biochemie. Springer Spektrum, Berlin, Heidelberg, 2013. 993-1024.

[30] Zänker, Kurt. Das Immunsystem des Menschen: Bindeglied zwischen Körper und Seele. Vol. 2049. CH Beck, 1996.

[31] Kugler, Peter. Der menschliche Körper: Anatomie Physiologie Pathologie. Elsevier Health Sciences, 2017.

[32] Techopedia, "Techopedia," [Online]. Available: https://www.techopedia.com/definition/20971/network-database. [Accessed 18 02 2020].

[33] Bader, G. D., Betel, D., & Hogue, C. W. "BIND—the biomolecular interaction network database." Nucleic acids research 29.1 (2001): 242-245.

[34] Lunt, Christopher, and Nicholas Galbreath. "Method for sharing relationship information stored in a social network database with third party databases." U.S. Patent No. 7,478,078. 13 Jan. 2009.

[35] Bionity, "Bionity," [Online]. Available: https://www.bionity.com/en/. [Accessed 28 12 2019].

[36] One vaccination Technology To Cure All Virusus, Including Coronavirus: Jacob Glanville - MindFull Channel. [Movie]. 2020.

[37] Distributed Bio, "Distributed Bio," [Online]. Available: https://www.distributedbio.com/superhuman. [Accessed 23 04 2020].

[38] Distributed Bio, "Distributed Bio," [Online]. Available: https://https://www.distributedbio.com/tumbler. [Accessed 23 04 2020].

[39] Aerts, Olivier, et al. "FreeStyle Libre: contact irritation versus contact allergy." The Lancet 390.10103 (2017): 1644.

[40] Boscari, F., et al. "FreeStyle Libre and Dexcom G4 Platinum sensors: accuracy comparisons during two weeks of home use and use during experimentally induced glucose excursions." Nutrition, Metabolism and Cardiovascular Diseases 28.2 (2018): 180-186.

[41] Kamann, Stefanie, and Eva Oppel. "Hydrocolloid blister plaster decreases allergic contact dermatitis caused by Freestyle Libre and isobornyl acrylate." Contact dermatitis 81.5 (2019): 380-381.

[42] Chou, Belle L. "Aloe vera glove and manufacturing method." U.S. Patent No. 6,423,328. 23 Jul. 2002.

[43] Poss, Valerie. "Heel moisturizing patch." U.S. Patent Application No. 11/133,985.

[44] Poppendieck, W. “ Vorlesung Aktive Implantate” Hochschule Mannheim (2019)

[45] Fraunhofer Institute for Integrated Circuits IIS, "iis Fraunhofer," [Online]. Available: https://www.iis.fraunhofer.de/de/ff/lv/iot-system/tech/energy-harvesting.html. [Accessed 28 12 2019].

[46] Ansari, M. H., and M. Amin Karami. "Piezoelectric energy harvesting from heartbeat vibrations for leadless pacemakers." Journal of Physics: Conference Series. Vol. 660. No. 1. IOP Publishing, 2015.

[47] Islam, Mohd Noor, and Mehmet R. Yuce. "Review of medical implant communication system (MICS) band and network." Ict Express 2.4 (2016): 188-194.

[48] Medizin & Technik, "Medizin & Technik," 29 02 2016. [Online]. Available: https://medizin-und-technik.industrie.de/medizin/news-medizin/wo-bindegewebe-nicht-gern-waechst/. [Accessed 28 12 2019].

[49] Fricain, J. C., et al. "Cellulose phosphates as biomaterials. In vivo biocompatibility studies." Biomaterials 23.4 (2002): 971-980.

[50] Modulevsky, Daniel J., Charles M. Cuerrier, and Andrew E. Pelling. "Biocompatibility of subcutaneously implanted plant-derived cellulose biomaterials." PloS one 11.6 (2016).

[51] Faller, Adolf, and Michael Schünke. Der Körper des Menschen: Einführung in Bau und Funktion. Georg Thieme Verlag, 2012.

[52] Kugler, Peter. Der menschliche Körper: Anatomie Physiologie Pathologie. Elsevier Health Sciences, 2017.

[53] Horn, Thomas FW, et al. "Early physiological abnormalities after simian immunodeficiency virus infection." Proceedings of the National Academy of Sciences 95.25 (1998): 15072-15077.

[54] Bell, J. F., and G. J. Moore. "Effects of high ambient temperature on various stages of rabies virus infection in mice." Infection and immunity 10.3 (1974): 510-515.

[55] Ruiz, Marilyn O., et al. "Local impact of temperature and precipitation on West Nile virus infection in Culex species mosquitoes in northeast Illinois, USA." Parasites & vectors 3.1 (2010): 19.

[56] Kuzuya, T., et al. "Human C-peptide immunoreactivity (CPR) in blood and urine—evaluation of a radioimmunoassay method and its clinical applications." Diabetologia 12.5 (1976): 511-518.

[57] Babbs, Charles F., et al. "Relationship of blood pressure and flow during CPR to chest compression amplitude: evidence for an effective compression threshold." Annals of emergency medicine(1983).

[58] Kuzuya, Takeshi, et al. "C-peptide immunoreactivity (CPR) in urine." Diabetes 27.Supplement 1 (1978): 210-215.

[59] Gray, Mark, et al. "Implantable biosensors and their contribution to the future of precision medicine." The Veterinary Journal 239 (2018): 21-29.

[60] Kim, Taeil, et al. "3D Printed Disposable Wireless Ion Sensors with Biocompatible Cellulose Composites." Advanced Electronic Materials 5.2 (2019): 1800778.

[61] Roingeard, Philippe, et al. "Virus detection by transmission electron microscopy: Still useful for diagnosis and a plus for biosafety." Reviews in medical virology 29.1 (2019): e2019.

[62] C.-A. Kurz and A. Lorenz, "Uni Bayreuth," 2016. [Online]. Available: http://daten.didaktikchemie.uni-bayreuth.de/umat/elektronenmikroskop/elektronenmikroskop.htm#3.Das%20Transmissionselektronenmikroskop%20(TEM). [Accessed 16 03 2020].

[63] V. Akimkin, "FU Berlin," 2013. [Online]. Available: https://refubium.fu-berlin.de/bitstream/handle/fub188/12290/Akimkin_online.pdf?sequence=1. [Accessed 16 03 2020].

[64] Strunz, Ulrich. Blut - Die Geheimnisse unseres» flüssigen Organs «: Schlüssel zur Heilung. Heyne Verlag, 2016.

[65] Tengyu, Zhang, and Melissa A. Mefford. "Gene editing in yeast cells using the CRISPR/Cas9 system." Morehead State University, Morehead KY USA (2019).

[66] Doudna, Jennifer A., and Emmanuelle Charpentier. "The new frontier of genome engineering with CRISPR-Cas9." Science 346.6213 (2014): 1258096.

[67] Hartweger, Harald, et al. "HIV-specific humoral immune responses by CRISPR/Cas9-edited B cells." Journal of Experimental Medicine 216.6 (2019): 1301-1310.

[68] Somanna, M. B. "Nanobots: The future of medical treatments." Int J Sci Tech Res 4 (2015): 276-278.

[69] Ding, Tao, et al. "Light-induced actuating nanotransducers." Proceedings of the National Academy of Sciences 113.20 (2016): 5503-5507.

[70] Ding, Tao, et al. "Research data supporting" Light Induced actuating nanotransducers (ANTS)"." (2016).

[71] Reiner, Bruce. "Nanobots with embedded biosensors." U.S. Patent Application No. 16/503,920.

[72] Krause, Felix, and Matthias Frentzen. "Dioden-Laser in der zahnmedizinischen Anwendung." Parodontologie 810 (2007): 980.

[73] Kilgore, George A., and P. Rand Whillock. "Skin detection sensor." U.S. Patent No. 7,446,316. 4 Nov. 2008.

[74] Gonçalves, André, André Godinho, and Joao Sequeira. "Low cost sensing for autonomous car driving in highways." ICINCO-RA (2). 2007.

[75] Kianpisheh, Amin, et al. "Smart parking system (SPS) architecture using ultrasonic detector." International Journal of Software Engineering and Its Applications 6.3 (2012): 55-58.

[76] Schmidt-Milkau, Claudia M., Klaus Disterer, and Rolf E. Hanitsch. "Measuring elevator car position using ultrasound." U.S. Patent No. 5,223,680. 29 Jun. 1993.

[77] A. Raimondo, "CERN Knowledge Transfer," [Online]. Available: https://kt.cern/technologies/remus. [Accessed 29 11 2019].

[78] Myers, Andrew C., and Barbara Liskov. "A decentralized model for information flow control." ACM SIGOPS Operating Systems Review 31.5 (1997): 129-142.

[79] Aitzhan, Nurzhan Zhumabekuly, and Davor Svetinovic. "Security and privacy in decentralized energy trading through multi-signatures, blockchain and anonymous messaging streams." IEEE Transactions on Dependable and Secure Computing 15.5 (2016): 840-852.

[80] Grundy, Gregory. "Method and system for decentralized manufacture of copy-controlled software." U.S. Patent No. 5,291,598. 1 Mar. 1994.

[81] De Filippi, Primavera. "The interplay between decentralization and privacy: the case of blockchain technologies." Journal of Peer Production, Issue 7 (2016).

[82] Aissi, Selim, et al. "Multi-authentication for a computing device connecting to a network." U.S. Patent No. 7,373,509. 13 May 2008.

[83] Kumar, Satish, and Anita Ganpati. "Multi-authentication for cloud security: A framework." International Journal of Computer Science & Engineering Technology 5.4 (2014): 295-303.

[84] Azaria, Asaph, et al. "Medrec: Using blockchain for medical data access and permission management." 2016 2nd International Conference on Open and Big Data (OBD). IEEE, 2016.

[85] Zeidler, Howard M. "End-to-end encryption system and method of operation." U.S. Patent No. 4,578,530. 25 Mar. 1986.

[86] Mock, Marcel, and Olivier Swedor. "End-to-end encryption method and system for emails." U.S. Patent No. 8,726,026. 13 May 2014.

[87] Voigt, Paul, and Axel Von dem Bussche. "The eu general data protection regulation (gdpr)." A Practical Guide, 1st Ed., Cham: Springer International Publishing (2017).

[88] Die Bundesregierung, "Die Bundesregierung," [Online]. Available: https://www.bundesregierung.de/breg-de/themen/europa/bedingungen-fuer-den-beitritt-zur-europaeischen-union-434536. [Accessed 03 05 2020].

[89] Chari, Ravi VJ, Michael L. Miller, and Wayne C. Widdison. "Antikörper-Wirkstoff-Konjugate: ein neues Konzept in der Krebstherapie." Angewandte Chemie 126.15 (2014): 3872-3904.

[90] Fieth, Christian, Anna Kebig, and Klaus Mohr. "Bevacizumab gegen Dickdarmkarzinom. Angiogenese-Hemmung in der Krebstherapie." Pharmazie in unserer Zeit 36.6 (2007): 442-445.5.

[91] Neumann, Jens, et al. "Very-late-antigen-4 (VLA-4)-mediated brain invasion by neutrophils leads to interactions with microglia, increased ischemic injury and impaired behavior in experimental stroke." Acta neuropathologica 129.2 (2015): 259-277.

[92] Müller, Thomas. "Antikörper verbessert Motorik." InFo Neurologie & Psychiatrie 15.4 (2013): 59-59.

[93] Kessing, Richard. "B-Zellen und MS: Welche Option bietet der gegen B-Zellen gerichtete Antikörper Ocrelizumab?." Fortschritte der Neurologie· Psychiatrie 85.05 (2017): 246-247.

[94] Pollack, C. V., P. A. Reilly, and J. Eikelboom. "Antikörper gegen Blutungen." Journal Club AINS 4.04 (2015): 214-214.

[95] Weber, Ralph, and E. Busch. "Thrombophilias in patients with ischemic stroke. Indication and calculated costs for evidence-based diagnostics and treatment." Der Nervenarzt 76.2 (2005): 193-201.

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