



LIVON
LIVING INNOVATION

Smart Healthy Living & Wellbeing

Knowledge Unit

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1. Introduction

The focus of this *knowledge unit* is on smart healthy living, wellbeing and prevention. As those topics are closely related to Smart Health and eHealth in general, we start providing an overview of definitions to understand how the different areas of knowledge are framed and connected.

1.1 What is Smart Health

The ActiveAdvice project¹ refers to smart healthcare as a new form of healthcare where technology allows the development of “better diagnostic tools, better treatment for patients, and devices that improve the quality of life for anyone and everyone”. Smart health encompasses eHealth and mHealth services, electronic record management, machine learning and intelligent and connected medical devices.

The smart concept also relates to Self-Monitoring Analysis and Reporting Technologies. Nowadays, smart technology is expected to make life of the user easier. In the case of smart health, it means the technology will improve the quality of life of the patient, user, family or citizen.

In general, smart technologies cover different forms of technological applications:

- Physical sensors with which to register data from its surroundings
- Computational capacity with which to store and analyse the data
- The means to deliver either actionable advice tailored to the end-user or automated actions, based on the data input

Smart Health Technologies apply the above to the healthcare sector. Currently, the advances of technology have already been adopted experimentally to assist in providing care and wellbeing for persons in need for several decades. Smart Health is built to support the healthcare sector with innovative ICT (Information and Communication Technologies), for example by promoting telemedicine and early detection approaches. Smart Health Technologies need data from the patient in order to properly work. For example, in the case of remote monitoring, data from the patient is extracted and analysed so that early detection or personalised treatment are performed, gaining an improvement in the patient’s quality of life and his/her surroundings (family, friends, caregivers, etc).

Further research and development are still needed to ensure accuracy of data, security of the devices, and others. Limitations are related to the difficulties of accommodation or incorporation of the technologies in daily operations. **Smart Health Technologies** are still in their infancy and the reliability of the data is still not high enough for healthcare providers or end-users to rely on the precision and accuracy of the data.

1.2 Smart Healthy Living & Wellbeing & Prevention

Smart Healthy living and wellbeing deals with the physical and emotional health condition of the human being. Let’s define them separately so that their differences and similitudes can come up.

Here is what we mean by healthy living, wellbeing and eHealth, as well as how those concepts relate to prevention, so that all the content of this Knowledge Unit can be well understood.

- **Healthy Living** deals with having a good health status by following healthy habits; lifestyle that leads to good health. Healthy habits are usually associated with:

- **Good nutrition**, such as considering a variety of foods and eating regular meals. Depending on individual conditions, recommendations may be to have three meals per day and a diet

¹ <https://www.activeadvice.eu/news/concept-projects/what-is-smart-health-and-how-do-people-benefit/>

consisting essentially of fruits, vegetables, whole grains, lean meats, poultry, fish, beans, eggs and nuts.

- **Physical activity and exercise** are considered to contribute to a healthy lifestyle. Exercise at any age is beneficial not only for preventing and reversing age-related decreases in muscle mass and strength; but it also helps increase self-esteem and self-confidence, decrease stress and anxiety, enhance mood, and improve general mental health.
- **Good sleep.** Insomnia and not enough sleep can impact on one's quality of life. Sleep problems can be caused by worries, a sleep disorder, changes in routine, or stress at work among others.
- **Limiting the consumption of drugs** also contributes to what is considered a healthy lifestyle, reducing the risk of cancer, addictions, and other physical and mental diseases.

- **Wellbeing** is related to people's behavior and motivation. This concept can be defined as the satisfaction, calmed or peace state of mind. Mostly it is due to good physical and mental conditions. The mood depends on the positive emotions and links the compromise and the success.

- **eHealth** uses ICTs applied to health, as for example the medical devices. The World Health Organization defines: "eHealth is the use of information and communication technology (ICT) for health. Examples include treating patients, conducting research, educating the health workforce, tracking diseases and monitoring public health".

- **Prevention** in health typically considers the methods or activities a person may follow to prevent or reduce specific or predictable health issues, to protect their current state of well-being, or to obtain a desired healthy status. Prevention is normally used in the sense of preventing diseases instead of curing or treating them. There are three levels of preventive care:

- *Primary*: Deals with healthy individuals, which aim is to avoid the appearance of a disease or issue.
- *Secondary*: Deals with the individuals at early stage of disease development or detection, preventing its worsening, emergence of symptoms or minimize future complications.
- *Tertiary*: Deals with un-healthy individuals trying to improve their quality of life. This third and last level aims to reduce negative impact and complications of an already- established disease.

Having all these concepts in mind, smart healthy living and wellbeing make use of the smart technology to satisfy the needs explained above. For example, recording the data from the patient, being able to know the status both physical and mental of the person, and be able to offer personalized treatments to prevent, cure, improve or stabilize whatever the patient may have. Smart technologies help to improve the quality of life of the persons by knowing their health and wellbeing status.

2. How can Technology support Healthy Living, Wellbeing & Prevention?

The combination of recording personal health data and the possibilities within Data Analytics enable Smart Health Technologies to provide engaging and personalised output. In the future, machine learning may enable Smart Health solutions to provide users with predictive recommendations based on their lifestyle recorded through different data sources.

There are multiple areas where smart technology can help in health, not only in IoT or telemedicine which are the most common seen with remote monitoring, but also in machine learning for genetics or predicting cancer or metastases in cancer, among others. There are a lot of fields where smart technology can be used. In health, the most frequent application areas at this moment are: frailty, cancer and its metastases, cardiovascular and pulmonary diseases, chronic conditions and genetics.

The technology is used to support / encourage / motivate healthy habits to ensure healthy living, wellbeing and prevention. In this section of the *Knowledge Unit* different technologies and application areas related to the benefit of healthy living, wellbeing and prevention, are described.

2.1 Vital signs checks

Vital signs are measurements performed by medical professionals and health care providers. There are four main vital signs including: body temperature, pulse rate, respiration rate (breathing rate) and blood pressure. This last one is not considered as a vital sign as such, but it is measured along with the other three.

Vital signs' normal ranges vary with age, weight, gender and overall health. Anyway, here are the commonly used standards for those vital signs. This should be taken just as an advice, being above or below that number does not necessarily mean there is a problem. It is the doctor the one that judges the results obtained with these measurements.

- **Temperature** standard ranges varies from 36.5 to 37 degrees.
- Normal **pulse** for healthy adults oscillates from 60 to 100 beats per minute. Females for example tend to have faster heart rates than males; athletes, in the contrary have rates near 40 beats per minutes, and both are considered normal pulses.
- **Respiration rates** at rest for an adult person varies from 12 to 16 breaths per minute.
- **Blood pressure's** normal rates are systolic of less than 120 and diastolic of less than 80 (120/80)

Vital signs can be checked or monitored differently considering scenarios of use, the type of monitoring, and the type of user (see figure 1). The wearable devices help people monitor in a good way the health status, not only for self-tracking activity/fitness level and resistance, but also to provide more data to the doctor being able to potentiate early diagnosis or guidance in a treatment.

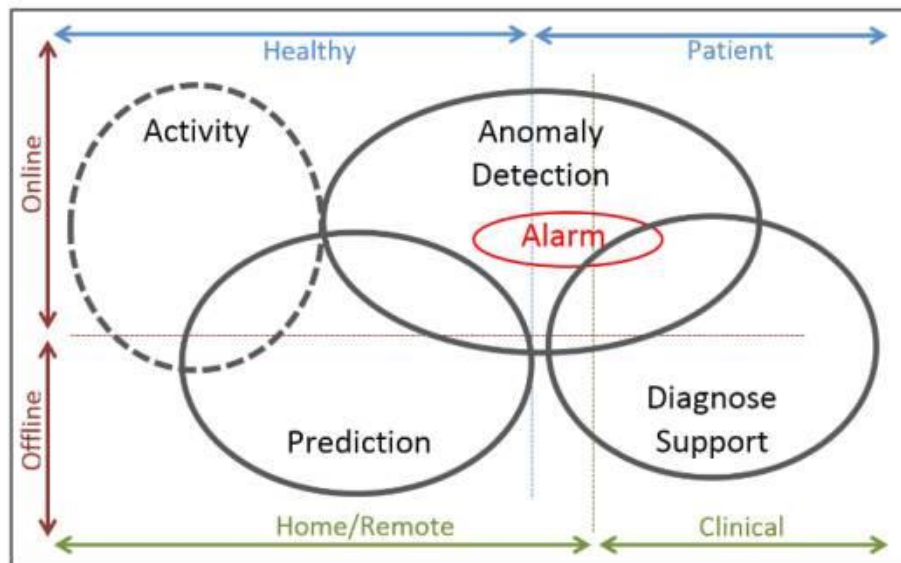


Figure 1: Vital sign monitoring scenarios²

In the European R&D project called **HeartMan³**, vital signs from the patient are monitored through a wearable and sent to a web app to the physician. In this project, there are two apps, one mobile app for the patient with physical exercises plan, nutrition plan, reminders for taking the pills treatment, and mindfulness exercise; a web app for the physicians with the recorded data from the patients and were treatment for example could be changed and synchronized with the mobile app of the patient. In this sense, the monitored vital signs could be checked and in case of any decline, the physician will know it.

2.2 Remote monitoring / coaching

Remote health monitoring is a diverse field, but it contains similar components. On the one hand it is needed a monitoring wireless device (which is normally a sensor) which will be measuring specific data from the person and will transfer that data to the healthcare professional and the person itself. On the other hand, a platform to store all this data is crucial, as well as the software that will analyze the data, and will give recommendations or alerts (if any). Monitoring technologies relying on smartphone apps are becoming popular as it allows the person to monitor its own symptoms and get the data in real time.

Summarizing the main technological components of the remote monitoring are:

- Wireless-enabled sensors which measure specific data or parameters from the patient, physical or physiological. These sensors send their information wirelessly to both the patient and the healthcare professional
- A platform storing all the information communicated by the sensors
- A software able to analyze the information obtained from the sensors in order to offer treatment recommendations and alerts, for example.

Remote health monitoring comes from the patient's need to monitor their health outside hospitals and without the sphere of healthcare professionals, improving access to care and decreasing healthcare costs. The remote monitoring system uses technology to monitor people out of the clinical environments, as it could be at home. Remote health monitoring can improve patient's quality of life suffering from numerous conditions, as can be heart conditions, diabetes or senior care. In the case of chronic diseases, incorporating this type of technology can significantly improve quality of life of

² Source: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6111409/>

³ <http://heartman-project.eu/>

the patient. It allows the patient to be more independent, prevent any kind of complication at the same time as minimizing personal costs.

Some of the type of sensors in this remote health monitoring are:

- Glucose meters for patients with diabetes
- Heart rate or blood pressure monitors
- Continuous location monitors for patients with conditions like dementia
- Fall detection monitor
- Caloric intake or diet programs
- Velocity sensors

Most of the projects centered in personalization of health deal with remote monitoring. In addition to the previously mentioned project **HeartMan** which remotely monitors the vital signs from the patient through a wearable, EIT Health **POSITIVE**⁴ is a project where older adults are monitored at home to prevent frailty and personalize the treatment each of them have to improve their quality of life and independency.

Thanks to the remote health monitoring, it is possible to have a reduction in the number of emergency visits, hospitalizations and hospital stays, as early detection of any kind of problem is easily detected. The wireless mobility makes it easier to implant the remote health monitoring in community and institutional settings, as it could be for example in nursing homes.

2.3 Mental Health services

There are many types of mental health services a person may need during his or her life. It can be short or long term depending on the difficulty of the disorder. Here below are mentioned types of mental health services:

- Emergency rooms: Depending on the hospital, it may have psychiatric emergency rooms or just the general emergency room. The psychiatric emergency rooms are prepared for those with psychotic or suicidal distress.
- Hospital inpatient: Hospitals normally have a service for mental health disorder treatment where those acutely ill or having additional physical illnesses can come. Stays at hospitals are usually short. There may be specialized psychiatric hospitals that treat behavioral and mental health issues itself.
- Outpatient mental health services: This consists on programs where patients live at home but go to a facility for treatment. Depending on the program, it may be more or less regularly per day, or week.
- Private practice: Many people prefer to have a personalized consultation and treatment, so they normally go to a private practice office. This are driven by psychologists or psychiatrists.
- Telepsychiatry, Telemental Health: In this case, the services are offered remotely, over the phone, internet, online calls, etc.

The mental health services are differently depending on the country. As an example, in the UK mental health services are free, but in some cases a referral from the General Practitioner is needed to access. In Spain, psychiatric services are included in the social security of health, however, there is a payment needed in the case of psychological services.

Mental services are related to the wellbeing of the patient. Depression, anorexia or dementia, are examples of mental disorders. Mental disorders can be developed due to other diseases a patient may have. For example, depression can be caused because of chemotherapy in patients with cancers.

⁴ <https://eithealth.eu/project/positive/>

Technology is used to stimulate the patient, for example with apps of mindfulness, or exercises developing cognitive aspects. In the market, it can be found not only apps considering the wellbeing of the citizen, but also robots that can guess human feelings and try to lift them up.

2.4 Medication / Therapy support

The first important question we may have in mind is: why do we take medicines? The answer is that we take medicines to cure, halt, or prevent disease; ease symptoms; or help in the diagnosis of illnesses. The final ending is to cure diseases and save lives.

It is very important that patients take the prescribed medication routine by the doctor. This means, taking the right dose, at the prescribed right time. The contrary (not taking these medicines) could lead to a worsening of the disease, hospitalization or even death.

In this sense, technology can help in the above mentioned. Alarms through apps are the most common in the market right now. There also exist the possibility of having a kind of communication patient-doctor through the app, where the patient can tell side effects of the medication, and comment whether the treatment suits or not him/her, and the doctor, taking that information into account, can change the prescription through the app, with no need of having a consultation just for that.

2.5 Nutrition and Physical Activity

Good nutrition habits permit citizens to be more active, energetic and healthy. An equilibrated diet is confirmed/tested to be satisfactory/good for any person. Prevention of obesity, diabetes, and all chronic diseases related to a bad nutrition habits, is as simple as knowing what best fits in a dietary and physical routine and make it possible.

Combination of a healthy dietary routines with physical exercise makes the complete circle of a healthy wellbeing. These two helps not only physically, but also mentally. It is proved to help brain activity, as individuals release toxins when doing exercise, and eating healthy makes them feel better.

With the increasing obesity and people addicted to unhealthy food rates, there is a need to improve the nutritional habits. Technology is a good vehicle to help in improving those habits. There are different apps with food scans to provide the consumer with important nutritional information. These apps are changing the way consumers buy products as people know what they are consuming and deciding whether something is good enough or not for the diet they want. Examples of this apps are *Yuka*⁵ and *Myrealfood*⁶.

There are also apps created to avoid long lines at the restaurants. For example, *UberEats*⁷, which brings to customers the food ordered right to their doorstep. This enable busy people to eat healthy without spending a lot of time.

There are other apps in charge of making people move, with training exercises adapted to individual's needs. For example, depending on how much time they have for doing the exercise, how intense they want it to be, and also which type of exercise (e.g. cardio, pilates, hiit, etc.). For example, the *NIKE*⁸ app has all these filters to advise the exercise that best fits each one.

Moreover, there are apps that have not only the exercise part, as the NIKE app, but also some dietary menus or advices for each individual to follow, combining nutrition and physical activity. Normally, this apps ask the person for their body shape, their body weight, and other parameters,

⁵ <https://play.google.com/store/apps/details?id=io.yuka.android&hl=es>

⁶ https://play.google.com/store/apps/details?id=es.myrealfood.myrealfood&hl=es_419

⁷ <https://www.ubereats.com>

⁸ <https://play.google.com/store/apps/details?id=com.nike.omega>

to proportionate the best meals and menus so that they can reach the objective they want, either if it is losing weight or just being healthy. For example, the app *FitnessBlender*⁹, or *SWEAT*¹⁰.

All these mentioned apps not only give advice to the consumer but can also maintain a follow-up considering if the nutrition and physical activity is correct. Too much training and low meals may be bad habits too, even though the nutrition follows good dietary requirements.

2.6 Postural monitoring

Currently work-related disorders yield a significant cost for society. Maintaining a good posture and changing position from time to time is considered to significantly improve and maintain personal health. Monitoring the posture of an individual is useful for workers dealing with heavy objects, being seated long hours at an office, standing up long hours, etc. But it is also useful for the seniors which may have back problems or may have falls. Monitoring their posture may prevent future falls, body breaks or chronic pains.

There is a great need for prevention of occupational health-risk for preventing accidents, by improving health and wellbeing at work and at home in the case of senior people, or chronic patients.

There are lots of new advances in technology related to sensors enabling big opportunities for different study fields. Postural monitoring sensors can be in different forms, from a static sensor at home controlling the person daily, to a t-shirt with sensors controlling all movements of a person.

In the **We@Work** EIT Health project¹¹, a multiservice cloud personalized platform combining wearable and unobtrusive sensing technologies was created. The technologies were used to perform initial assessment of potential loss of capacity of the employee for operating with potentially dangerous machinery. The platform provided warnings and recommendations for intervention. The sensors were embedded in a t-shirt and wearables to monitor the worker for a whole day.

In **POSITIVE**, above-mentioned, a platform is also created receiving data from sensors placed at senior's house, monitoring the adult to prevent frailty. Also, warnings and recommendations for interventions are made and sent to the doctor, who receives all the data from the sensors, and the analysis of the alarms. Depending on the data received, the doctor will take a decision, whether to see the older adults at the consultation or give him recommendations before coming again.

2.7 Health & Smart homes

Logically, smart technologies for eHealth are somehow overlapping with smart technologies for home, as many applications to monitor and improve health, prevention and wellbeing, are related to the home context (e.g. sensors for room temperature, motion detectors, air quality, etc.). The LIV_IN project covers this aspect in detail in another document, which can be found on the website¹².

⁹ <https://www.fitnessblender.com>

¹⁰ <https://www.sweat.com/>

¹¹ <https://eithealth.eu/project/wework/>

¹² <https://www.living-innovation.net/explore>

3. Ethics & Responsible Innovation Aspects

Bringing technology into the sphere of healthcare services brings with it, relevant ethical considerations. In this section considerations are taken into account and briefly described to have an overview of what to have in mind.

3.1 Data & Privacy

3.1.1 GDPR

The General Data Protection Directive (GDPR) from EU entered into force in May 2018. The purpose of the directive is to strengthen citizens' fundamental rights when it comes to data, privacy and digitalisation – but also to simplify rules for companies and thereby facilitate growth. Some of the more noteworthy changes enforced by the directive are the possibilities of issuing fines amounting to up to 4% of a company's annual turnover.

In order to adhere to the GDPR, companies may look at the Guidelines for Cybersecurity ([ISO 27032](#)).

3.1.2 Consent

The regulation regarding data subject consent has been further strengthened and clarified. Consent must be explicit, and the citizen must be clearly informed of the precise and defined purpose of data collection. Furthermore, the citizen has the right to revoke consent. If consent is revoked the data must be deleted and proof that it has taken place presented to the citizen. This will affect all companies handling data pertaining to the citizen's health.

3.1.3 Data portability

Data portability is a new topic introduced by the GDPR. With GDPR the citizen will have the right to data portability. This means that if you collect personal data the citizen has the right to receive the personal data concerning him or her in a structured, commonly used and machine-readable format. They also have the right to transmit the data to another organization that collects data about the citizen. The purpose of this obligation is to limit the number of times citizens must answer questions about the same subject matter, e.g. age, height, gender etc.

This is particularly interesting from a healthcare perspective because data might be required to be shared across different organisations in the healthcare sector to a much greater extent than they are today. This might also prove a new business opportunity for companies, since there may be a whole new market emerging for solutions to support data portability, e.g. by providing system integration or sharing information between different IT systems.

3.2 RRI Tools

RRI (Responsible Research and Innovation) implies the participation of different actors, from researchers to governments, in all the stages of a research and innovation process. This helps the alignment with the values, necessities and public expectations. It is not only ethics and socially valuable, but it will produce a better science, taking into account the real-world necessities.

RRI Tools are important to anticipate possible future problems, anticipating solutions if those finally appear.

4. Conclusive remarks

As a conclusion, technology should be seen as a helper in health; our data is very important for diagnosis, research, wellbeing, and even physical training. The usage of technology can aid us obtaining recent data, real in-time data, and of course, in some cases it may make us feel comfortable (with exceptions as usual).

The objective of this knowledge unit was to provide a high-level overview of what smart technologies are and how they can be of use in the health sector, in particular regarding healthy living, wellbeing and prevention. However, we consider that there are still topics that may be considered in an extended version of the document, such as socio-economic trends, focus on people empowerment, people perspectives (adoption, expectations, benefits) and market evolution.

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