EUcare4.0
R1: Introducing Health 4.0 to healthcare professionals

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Table of Contents

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1. What is Health 4.0 and how is it impacting the mental health sector?

"From wearable sensors to video game treatments, everyone seems to be looking to technology as the next wave of innovation for mental health care."

Thomas R. Insel. Neuroscientist, Psychiatrist and Entrepreneur

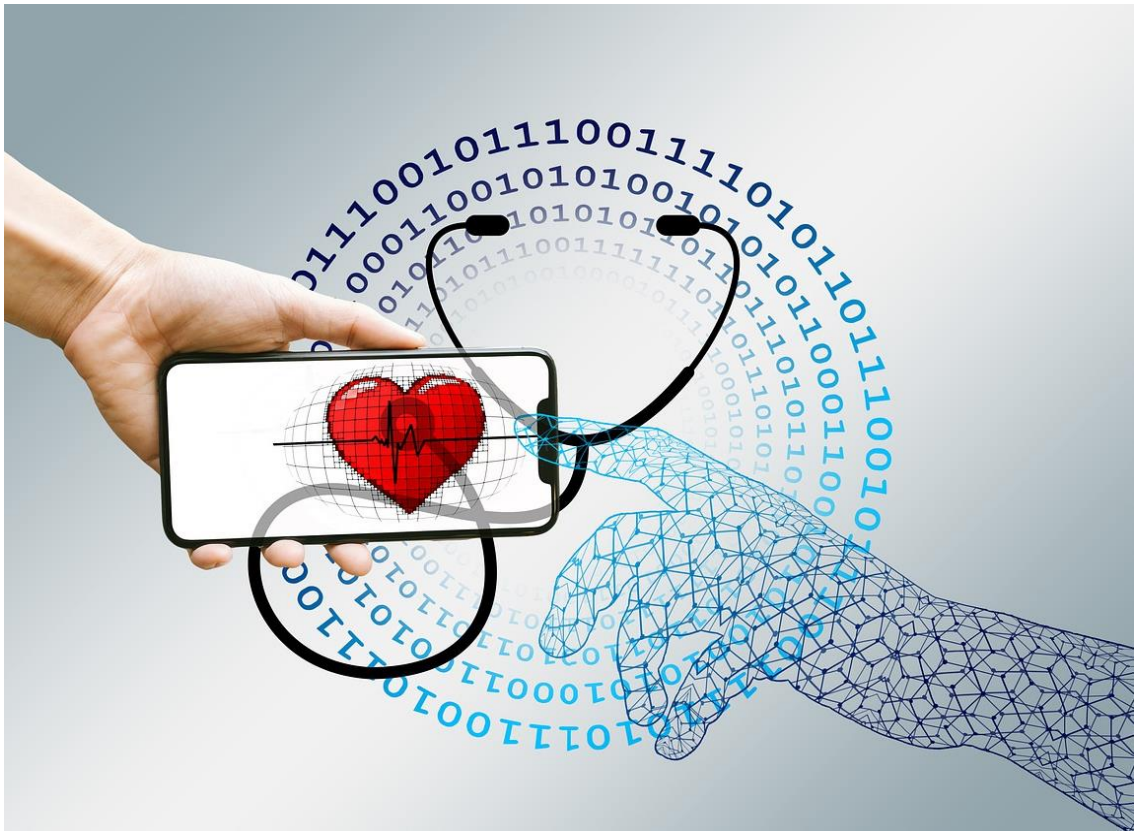

Figure 1.1: Health 4.0. Source: Pixabay

1.1. Introduction

Health 4.0 is the derivative of the "Industry 4.0" applied to the field of healthcare and under a different perspective, since in industry products are manufactured, but in healthcare people are cared for. There are aspects that are not applicable to healthcare. Health 4.0 is a model inspired by the term Industry 4.0 (Schwab, 2017) that embraces the incorporation of emerging enabling technologies to support the "healthcare personalization close to real-time for patients, workers, and both formal and informal caretakers" (Monteiro et al., 2018); these enabling technologies include cloud computing, smart devices, wearables, Internet of Things (IoT), Mixed Reality (XR) (Augmented and Virtual Reality AR/VR), Big Data, or Artificial Intelligence (AI), among others. In fact, some authors consider Health 4.0 as a subset of Industry 4.0 (Thuemmler, & Bai, 2017). As such, Health 4.0 related solutions should consider the six design principles for Industry 4.0

defined by Hermann et al. (2015) (Interoperability, Virtualization, Decentralization, Real-time capability, Service orientation, Modularity), but adding a seventh principle (Safety, Security and Resilience) since health infrastructures are critical infrastructures (i.e., vital to the daily functioning of public life) (Thuemmler, & Bai, 2017).

Although the concept of Health 4.0 has become popular in recent years, its implementation in the field of mental health has been limited to some pilot experiences and applications that can be found in the literature, several of them also related to wellbeing of citizens. Several literature reviews that explored the potential of Health 4.0 enabling technologies on mental health were published recently. For example, Tobon Vallejo & El Saddik (2020) did a literature review on the use of machine learning and deep learning techniques applied on data collected from sensors with the aim to detect the emotional state of citizens, detect anomalies and take actions to prevent mental disorders, stress problems, or mental health issues; their conclusions highlight the need for more trustworthy and efficient applications to detect events and prevent undesired consequences. Inal et al. (2020) did a literature review on the use of mobile applications aimed at dealing with mental health problems (mHealth), such as bipolar disorder, depression, eating disorders or schizophrenia, among others, concluding that it is necessary to standardize the questionnaires used to measure the usability of these applications. Finally, de la Torre Diez et al. (2019) did a literature review on IoT-based services and applications for mental health, concluding that the inclusion of IoT technologies bring many benefits in terms of monitoring, welfare interventions and providing alert and information services on mental health.

Nevertheless, before looking in detail at the different technologies that may be relevant in the field of Health 4.0, it is important to understand the types of diseases that may affect patients in the field of mental health. The following section introduces examples of mental health diseases, focusing on two specific cases and then mentioning some technologies that will be further detailed elsewhere.

1.2. Examples of Mental Health Diseases

It is imperative to have prior knowledge of the clinical field of mental health to address the impact of Health 4.0 in the mental health sector. With this objective in mind, a general outline of a Psychiatry Service taken as reference (Castilla-La Mancha Health System, Guadalajara, Spain) is presented, with the fundamental pillars of modern psychiatric care: i.e., outpatient care, brief acute hospitalization in the Mental Health Unit, and care for less serious patients who require very continuous care, in the day hospital. Furthermore, there are special pathologies, such as psychogeriatrics, severe alcoholic pathology, eating disorders, integrated care for patients with fibromyalgia, inflammatory bowel disease, and first psychotic episodes. An outline of units and main diseases treated in this reference Psychiatry Service is shown in Table 1.1.

Short-term hospitalization unit. Equipped with 13 beds. - Psychotic episodes. - Bipolar disorder. - Schizophrenia. - Detoxification. - Serious suicide attempts.	**Outpatient Mental Health Unit.** Consultations. - Mild psychotic episodes. - Mild bipolar disorder. - Mild schizophrenia. - Mild detoxification. - Mild suicide attempts.
Child and Adolescent Outpatient Mental Health Unit Consultations. Children and adolescents up to 17 years of age. Referrals come from the Primary Care Teams and accept referrals from other resources such as School Support Teams and Social Services. Specific psychodiagnosis. Specific psychopharmacological treatment. Specific psychotherapies (Individual, Group and Family). Psychoeducation. - Mild psychotic episodes. - Mild bipolar disorder. - Mild schizophrenia. - Mild detoxification. - Mild suicide attempts.	**Addictive Behavior Unit.** - Alcohol. - Cocaine. - Reefer. - Opiates. - Compulsive Eating Disorder.
Medium Stay Unit In patients 6-12 months/year -Severe mental illness.	**Long Stay Unit** Standard psychiatric center. Nursing home for the mentally ill.
Day hospital Adult 1-5 days - Psychiatric therapies. - First psychotic episodes that cannot be overcome. - Severe personality disorders. - Issues requiring follow-up.	**Day hospital for children and adolescents.** 1-5 days - Psychiatric therapies. - First psychotic episodes that cannot be overcome. - Severe personality disorders. - Issues requiring follow-up.

Table 1.1: Outline of units and main diseases related to mental health.

The diagnostic techniques to be analyzed are:

- Diagnostic interview.
- Instrumental personality diagnosis.
- Psychodiagnostics projective techniques.
- Psychometric evaluation of intelligence.
- Evaluation using neuropsychological batteries.
- Psychiatric social assessment
- Assessment of chronicity and relapses.

The therapeutic techniques are:

- Individual psychotherapy.
- Group psychotherapy.
- Treatment with regular psychotropic drugs.
- Intravenous perfusion pharmacological treatment.
- Monitoring of specific drugs such as clozapine and mood stabilizers.
- Protocolized electroconvulsive therapy (ECT).
- Parenteral nutrition.
- Opiate detoxification techniques with alpha-2 agonists.
- Naltrexone treatment techniques.
- Brief, focused, and dynamically oriented psychotherapy.
- Cognitive and behavior modification psychotherapy.
- Systematic desensitization
- In vivo exposure
- Thought stopping
- Autogenic training
- Relaxation techniques
- Stress coping techniques
- Cognitive techniques
- Couples therapy

Biological treatment techniques :

- Treatment with standard psychotropic drugs.
- Monitoring of specific drugs (Clozapine, mood stabilizers, delayed neuroleptics, antidementia drugs).

Psychoeducational programs.

Within these four groups, it is possible to introduce technologies that improve the techniques, although a priori a biological treatment does not seem conducive to a technological implementation, for example, to carry out monitoring based on IoT. It can be observed that from a first incursion into the field of mental health it is difficult to address a specific technique, or to direct a technology to a specific technique without going into more detail in each of them.

The Outpatient Day Hospital is an outpatient treatment that includes the main diagnostic and medical, psychiatric, and pre-vocational treatment modalities designed for patients with severe mental disorders who require intensive, comprehensive, and multidisciplinary coordinated treatment that cannot be provided in a normal outpatient setting. It is a time-limited, active, and intensive treatment aimed at overcoming crises or treatments of intermediate duration.

The timetable of activities in which patients participate is from 9:30 to 14:00, with 30 minutes. at the beginning and end of the day for team meetings as the start and summary of the day. The average number of patients using the Outpatient Day Hospital during the same period is between 15-20 patients, with an average stay of 6 months. It should be noted that there are patients who come every day of the week, but others only come 2 or 3 days a week.

The activities carried out are:

- Good morning group.
- Groups of creative activities and self-expression and dramatization (painting, writing, press workshop, theater).
- Daily life activities and health promotion groups.
- Leisure and recreational groups.
- Physical, body expression, psychomotor and relaxation activities.
- Verbal group psychotherapy. Therapeutic groups, "large group".
- Individual psychotherapy.
- Family psychotherapy or family interviews.
- Psychoeducation of families.
- Psychopharmacological treatment: administration and supervision of medication, although self-administration and self-responsibility are encouraged.

The objectives of the Outpatient Day Hospital are :

- Treatment of patients who cannot be treated on an outpatient basis, and who will not benefit from hospitalization, for example, when there is only partial remission of severe symptomatology, or when there is a rapid evolution towards significant deterioration and failure in socio-familial adaptation.
- Reduction of the duration of acute hospitalization, providing a transition from hospitalization to community reintegration.
- Avoidance of hospitalization in acute crises, or re-hospitalization in relapses.

Other more specific objectives are to ensure correct compliance with medication, improvement of the patient's daily living skills, assessment, diagnosis, and therapeutic approach in doubtful cases, and finally to organize specific activities after discharge in certain cases.

The psychiatric patients who will benefit most from this device are those aged between 16 and 65 years, preferably between 18 and 45-50 years, who suffer from a chronically evolving disorder with poor functioning, mainly those who are difficult or insufficiently addressed in the outpatient setting. Patients in acute crisis, except in imminent self- or hetero-aggressiveness. Depending on the diagnosis, indications include psychotic disorders, severe personality disorders, eating disorders, affective disorders of poor evolution, psychiatric disorders with comorbidity with substance or alcohol problems.

Within mental health we must not forget nursing care. Starting from the definition of nursing as "the diagnosis and treatment of human reactions to real or potential health problems", psychiatric nursing is characterized by the fact that it is based on an interpersonal process whose fundamental objective is to promote and maintain behaviors that contribute to the integrity and good functioning of patients. Sometimes the intervention to achieve this is carried out on the group to which the individual belongs (family, organization, or the whole community).

The activities of psychiatric nursing are:

- Creation of therapeutic environments.
- Intervening on the real problems of patients.
- Assuming the role of surrogate parent.

- Dealing with the somatic aspects of the mental patient's health problems.
- Teaching patients about factors related to mental health.
- Acting as social partners.
- Lead other professionals intervening on the psychiatric patient.
- Perform psychotherapeutic interventions.
- Participate in social and community activities related to mental health.

For a more direct approach to obtain viable results, it is necessary to rule out some serious mental illnesses such as schizophrenia as they are chronic and severe with altered perception of reality. It would not be feasible to introduce augmented reality, as it would become an augmented altered reality.

In order to serve as a guide for the project and with a view to the implementation of subsequent case studies, two clinical cases are presented that can be approached a priori for the incorporation of technologies that transform treatment techniques into Health 4.0 treatment techniques. A first case of mild mental illness or adaptive disorder and a second case of severe mental illness are shown below.

CASE 1 (Mild mental illness or adaptive framework)

68-year-old female patient who has been under outpatient follow-up for about five years.

- **Somatic Background**
  - No RAMC
  - No DL, HTA in treatment, DMNID in treatment.
- **Psychiatric history**
  - In follow-up for about five years. No admissions.
  - Current treatment:
    - Venlafaxine 150 (1-0-0)
    - Venlafaxine 75 (0-1-0)
    - Trazodone (Deprax) 100 (0-0-1/2)
- **Toxic habits**
  - No
- **Childhood**
  - Native of a village. Two sisters living in T and one brother in V. Widowed since 2014. Four children:
    - Female 47
    - Male 45
    - Male 40
    - Male 35
  - Two live with her. Another son lives in A and daughter in M. Five grandchildren, good relationship with all of them.
- **Current illness**
  - Patient attended the consultation accompanied by her son. The patient reports that she has been in a low mood during the month of April; it coincides with the date when she had to look after her father. She says that she has spent a month sad, not wanting to do anything. Now she feels better, smiles, and responds to

jokes. She did not take the Trazodone (Deprax) I prescribed at the previous check-up.

- **Psychopathological examination**
  - On examination she is conscious, oriented, cooperative. Subdepressed mood, no apathy, no anhedonia, no suicidal ideation. Insomnia on occasional days. No anxiety.
- **Diagnostic printout**
  - Anxious-depressive disorder
- **Treatment**
  - Venlafaxine 150 (1-0-0)
  - Venlafaxine 75 (0-1-0)
  - Trazodone (Deprax) 100 (0-0-1/2)
  - TA control
- I make an appointment for a check-up

CASE 2 (Severe mental illness).

This patient will have a video-consultation at times when she is not available to come in. 33-year-old female patient diagnosed with Schizoaffective Disorder who follows up monthly.

- **Somatic Background**
  - No RAMC
  - Gynecological and endocrinological alterations under study
- **Psychiatric history**
  - At the age of 28, he began consulting psychiatrists, after first presenting a depressive phase, and then a hypomanic phase. Initial follow-up with Dr. and later in private circuit. She has been followed up since 2020.
  - One admission to UHB in 2016, another in 2018 and the last in 2020. Diagnosed with schizoaffective disorder.
  - Current treatment:
    - Lithium carbonate (Plenur 400) (1-0-1 y 1/2)
    - Clozapine (Nemea 100) (0-0-1y 1/2)
- **Toxic habits**
  - Non-smoker. No alcohol. No consumption of other intoxicants.
- **Childhood**
  - Childhood without AVEs
- **Schooling**
  - Bachelor's Degree in Visual Arts. Degree in photography. Interior design not completed
- **Employment history**
  - Has worked in various clothing shops
  - Last job in logistics ended in February. Since then, she has not worked again except for a few days this Christmas when she worked in a mobile phone case shop.
- **Couple**
  - Single

- **Children**
  - No children
- **Family psychiatric history**
  - Two maternal siblings: unipolar depression.
  - Maternal uncle: deceased. TAB.
  - Cousins on father's side: mental health problems.
- **Current illness**
  - Patient being followed up in this consultation for Schizoaffective Disorder with good adherence. During the last few months, she has remained psychopathologically stable although with a certain apathy, asthenia, and ideo-affective impoverishment.
- **Psychopathological examination**
  - Conscientious, cooperative, maintains the usual standards of politeness and adequate eye contact. Normosomic. Impression of adequate nutrition and hydration. Normoprosexic. Self and allopsychically oriented. No amnesic lacunae. No clinical signs of intoxication or withdrawal. No sensory-perceptual alterations. No alterations in the course or content of thought. Subdepressive mood reactive to personal situations. Apathy, anhedonia. No emotional lability. No anxiety. No insomnia. No hyporexia. Denies self-harming ideation and verbalizes coherent and realistic plans. Critical judgment preserved. Adequate awareness of illness.
- **Diagnostic printout**
  - Schizoaffective disorder
- **Treatment**
  - Clozapine (Nemea 100) (0-0-1) I lower it
  - Lithium carbonate (Plenur 400) (1-0-1 and 1/2)
  - I give review appointment
- **Evolution and therapeutic recommendations**
  - The patient suffers from a serious chronic mental illness that affects her daily life and despite having an adequate awareness of her illness and good family support, she has serious difficulties when carrying out work activities or is at risk of decompensation in the face of stressors. She presents some ideo-affective impoverishment, distal tremor, and concentration difficulties. Close follow-up is recommended.

For CASE 2, as a real implementation of technology, still far from Health 4.0, a study was already done in 2011 (Drukker et al., 2011) and video consultation techniques are being employed to encourage remote consultation attendance in a way that favors more continuous monitoring, loss of travel time from villages far from the hospital. This video consultation system has been implemented at regional level and is being used regularly at the Hospital de Guadalajara by doctors.

Another important aspect when introducing a technology is the ethical and privacy aspects. In this case, during implementation, aspects such as the protection of personal data have been considered, with informed consent, as well as the security of communications through the implementation of secure firewalls.

At the hardware level, the basic system consists of a Sandberg Camera, USB Webcam Flex 1080P HD and Sennheiser Headset PC 8 USB. In addition to the corresponding software development for integration with the medical appointment and patient history application.

1.3. Health 4.0. Enabling technologies

There are several enabling technologies related to Health 4.0 (and analogous concepts such as smart/intelligent healthcare) that could be applied in cases such as those presented before. Many of these enabling technologies are also related to Industry 4.0 and beyond (Maddikunta et al., 2022). The first set of technologies involves the collection and processing of data through different sensors and devices located at the *individual* (typically patients). These sensors and devices include, for example, smartphones and wearable technology (e.g., smart watches, smart wristbands, smart rings, etc.), the connection of these devices with IoT technologies (and their extension in Internet of Everything - IoE - technologies), and the processing of data through cloud computing (and its extension for the processing of real-time data in edge computing and fog computing). These sensors and devices collect large amounts of data that can be used to monitor patients that may suffer from mental health issues and carry out interventions. For example, heart rate, time spent exercising, or sleep time could be relevant indicators obtained from these sensors and devices that can be used for the detection of stress, depression, or schizophrenia, among other mental health problems (Porrás-Segovia et al., 2021).

The second set of technologies involves adapting the home and work *environment* for both patients and caretakers. These technologies include, for example, Mixed Reality (XR) (AR/VR), which allows creating new environments where physical and digital objects co-exist and can interact in real time, and Ambient Intelligence (AmI), which embeds sensors and actuators into the environment without humans having to be aware of their existence. XR technologies can be used, for example, for the training of caretakers or for remote assistance and therapy of patients with mental problems, among others (Stone, 2020). AmI technologies can be used, for example, to automatically regulate the light or temperature in the house of a patient or a hospital depending on his or her emotional state as a form of intervention. AmI technologies typically involve the use of IoT technologies for the communication among sensors and actuators, and the processing of data via cloud or edge computing

The third set of technologies involves those that make it possible to have a global impact on the *community*. These technologies include, for example, mobile health applications (mHealth), as well as Big Data and Artificial Intelligence (AI) technologies, which rely on the sharing of large amounts of data collected from numerous patients to develop appropriate models and algorithms. Naturally, these technologies may also involve the use of other enabling technologies previously mentioned here. Regarding mHealth, it is important to ensure that the apps patients are going to use have been clinically tested to guarantee their effectiveness. For example, Marzano et al. (2015) detected that only a small fraction of all mental health apps available in app stores had been clinically tested, somewhat critical in such a sensitive subject as mental health. Big Data and AI technologies have a great potential to improve diagnosis, treatment, and monitoring of mental health problems (Passos et al., 2019; Graham et al., 2019). Studies using Big Data and AI technologies typically use as predictor variables for their models Electronic Health Records (EHRs) from patients, mood rating scales, brain imaging data, or

activity in social media platforms with the aim to predict depression, schizophrenia, or suicidal ideation/attempts (Graham et al., 2019). As more and more data are collected and shared, it is possible to improve predictive models to improve diagnosis and begin treatment as soon as possible. The following sections delve into these three sets of technologies from related literature.

1.4. Take action

Use knowledge acquired to take action	
Action Change Things	Google "technologies" to support "health 4.0" in "mental health" and look at the specific cases mentioned above. Think on how the technologies you found can support these cases.

1.5. Conclusions

The current reality shows a significant growth in the known pathologies of gestural suicide and consensual suicide in the field of mental health; these pathologies are also intensifying in adolescents. Added to this is an increase in the demand for treatment at the management level, where a greater number of doctors are required, patients who require closer and more flexible care, with mobility limitations, etc. On the other hand, today we have technologies that can help solve these challenges, which are appearing incipiently in the field of mental health, though, for example, video consultation, working with tablets or smartphones. But there are also advanced technologies that can enable a leap forward, not only from the management point of view, but also from the therapeutic point of view, such as cloud computing, smart devices, wearables, Internet of Things (IoT), Mixed Reality (XR) (Augmented and Virtual Reality AR/VR), Big Data, or Artificial Intelligence (AI). The future of mental health involves the inclusion of many of the aforementioned technologies to improve the mental health of an increasingly deteriorated society.

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2. Benefits of Health 4.0 for the Patients

"Nothing is impossible. The world itself says I'm possible".

Audrey Hepburn

Figure 2.1: Source: DC Studio – retrieved from https://elements.envato.com/scientific-microbiologist-doctor-analyzing-medical-FPY4AMS

2.1. Introduction

The first part of this chapter begins with the concept of 4.0. Industry and the medical area's development are under the influence of the changes induced by its development. Industry 4.0 represents a futuristic initiative of the German government in 2011. This initiative aimed to revolutionize production using digital means and the unbound potential of future technologies like A.I., robots, 3D printing, software applications, IoT., cloud computing, and so on.

In the context of global health challenges, quality, and safety, leadership, advanced practice, or innovation, medical professionals must always be prepared to face any situation and adapt to changes. The complexity of diseases is increasing, and at the same time, technology is advancing at a more rapid pace than ever. The difference these technologies will bring to the medical field will be huge. The automatization and data will change how we see health overall.

Many medical devices are being built to connect to the "internet" grid using I.O.T., to use big data, to analyze and independently manage processes almost in real-time, which can be translated into personalized medicine, lower costs, faster results, and so on. Further requirements for hospitals to follow these new conditions and for us to adapt. The use and implementation of these technologies are fundamental to innovation in the health sector and to building people-centered health policies.

To better understand what is specific to nursing in psychiatry, the second part of the chapter tries to define the concept of mental health and mental illness. Depending on the mental health

definition, the treatment and the patient's approach can differ, but the core of providing care is that people must be seen as persons beyond their diagnoses.

The last part of this chapter includes the pros and cons of using the 4.0 Industry in mental health care. Modern psychiatric treatments are known to have some side effects, and current treatment methodologies cannot adequately address the complexity of mental illness issues. As a result, many efforts have been made to find and implement communication technology (I.C.T.) and information applications, such as additional psychological treatment and alternative diagnoses. Studies are being conducted with the specific goal of analyzing the technical aspects of using IoT, big data analytics, virtual and augmented reality, artificial intelligence, and machine learning in the mental healthcare sector to enhance the efficacy and precision of patient care and diagnosis (Panwar et al., 2020).

2.2. The use of industry 4.0. in the medical field

The impact of 4.0 Industry on health sector

New ideas like paperless organizations and hospitals help us save time and money and deliver better, decentralized care using intelligent software. The interest is growing, so it's only natural that producers of such devices will want to stay competitive and deliver better and better products. Many startups emerge, and the field evolves faster than we can keep up. Also, by using big data, producers receive better and better feedback from patients. These are just a few examples that we will detail further in the next chapter.

We do not know if this is the answer we were looking for. We didn't figure out many things, like patient intimacy, software failure, cybersecurity, etc. This might be a small cost compared to the results, offering us a whole new view of all the active medicine available specifically for our body and our specific condition/ disease.

Although the A.I. invasion will happen only in movies, it changes and will change the lives of millions of people, for good and bad. Industrialization means advancement but also fewer jobs. The responsibility is on all of us to write good policies and protect the many.

Figure 2.2: Author: ckstockphoto. Retrieved from: https://elements.envato.com/science-and-medicine-scientist-analyzing-and-dropp-BUYCJZR

Examples of the utility of Industry 4.0. in health

We all feel the speed with which technology advances, and we must be prepared to use it. Many things change, but as we all know, the one sure thing is that everything changes.

A lot can happen, but one example would be that in the future, we could use human-focused simulated data that will recreate the real world, even in photo-realistic details. The fact that we can use these types of data to generate cases to be solved in classes is fantastic. The possibility of studying becomes unlimited. At a basic level, this technology already exists. We need to put it to work.

This fusion of technologies (A.I., IoT, Big Data, 3D printing) is starting to take fields like personalized medicine, genetic manipulation, V.R. and A.R., Robots, and medical wearables to a whole new level.

Let's take medical professionals' medical training, for example. Isn't it a pity that we use cutting-edge technology in areas such as social media but not in health? The goal is to immerse medicine as a practice field with the help of the most advanced technology, such as virtual reality, to enrich knowledge regarding real-world experience. We have 3D simulations, virtual learning environments, and other developments that can tremendously help, for example, in multi-disciplinary teams. It could create more barriers in the group or even technical activities if not used correctly.

We, as medical professionals, are always involved in finding innovative ways to integrate technology into practice, but technology also needs to be adapted better to our needs. In many European hospitals, we can see robots sorting pills for each person, robots that guide patients through the hospital. Manufacturers need to involve more medical professionals in (R&D) to help design their products and consider us as a partner in advancing digital health systems to improve patient care quality.

As advocates for well-being, we are placed across multiple types of settings, and we need to adapt to each situation. Furthermore, medical schools and universities are responsible for adapting the curriculum to the current needs. We need to shift our focus on balancing research skills using the scientific method with technological competencies to cope with the fast world we live in and combine it with social skills, so much needed in a job requiring a high level of empathy.

Immersive learning environments using virtual simulation (VS) technology are rising. Those are relevant because medical students train in limited clinical training hours and focus more on patient safety. It represents a particular category of medical students who are preparing to become maternal nurses and are trying to acquire clinical skills using simulators based on mannequins, subject to the hourly availability limitations of a simulator. And in the case of these students, augmented reality and simulation are ways of technological intervention that can be integrated into the medical care curriculum to improve their clinical skills' effectiveness.

Solutions implemented in medicine are often dedicated to training or planning the medical act. In this sense, endoscopic operations have now become a frequently encountered technique in treating various diseases and performing this type of intervention requires specific skills from

the doctor. Simulators implemented based on reality and virtual environments provide an elegant and risk-free training solution for the doctor to acquire these skills.

Technology can help nurses identify the best it comes when they draw blood. Augmented reality can assist surgeons, and medical students can practice high-stakes procedures without patient risk. Moreover, as we saw previously, virtual colocation through augmented reality makes it possible to interact with a specialist from anywhere, allowing access to medical assistance advanced worldwide.

In addition, mixed reality is successfully used in the recovery process of the patient who has suffered an act medically or showing an incapacity possibly caused by an accident. And here, we mean both haptic solutions, in which the patient is asked to handle virtual objects or activate different functions engines. Also, the solutions aimed at the mental side, such as the various phobias or the induction of certain mental states, divert the patient's attention from his suffering.

In simple terms, the Industrial Revolution used steam power to power the mechanization of production. Now, the industry 4.0 model is applying automatization to industries like health care and connecting them to the grid using IoT.

While much of the previously stated examples of the technology have significant value for health care, these examples are not the be-all and end-all of the value of the technology.

We've heard a lot about IoT in the enterprise and home. More specifically, with the continued adoption of smart home automation, the Internet of Things (IoT) is entering its second generation. The 3G and 4G eras were about connecting devices to a network. The next generation of IoT is centered around making those devices more intelligently connected to people. The new wave of IoT will leverage machines and people as the primary operating system.

Security, privacy, and reliability are why many IoT products are considered niche markets, but this is rapidly changing. IoT sensors installed in your home are used all the time, and location (yours and other devices' location) is constantly tracked.

Challenges and risks

There are a lot of concerns linked to the use of 4.0. Industry in general also applies to the general medical field and also in the way that care can be provided in psychiatry. As you can see in Figure 2.3 there are concerns regarding the technology, which implies cybersecurity, interoperability needs, data management and also storage, economic, like high cost of improvement, constraints linked to capacity and organizational competence, society: impacts on employability, resistance to change, the digitalization risks and the inequalities of opportunities. There are also concerns regarding knowledge, support, and environment, which are basically linked to technical support and resources (Caiado et al., 2022). Starting from defining Industry 4.0 (I4.0) as "a worldwide movement to improve the productivity and efficiency of operations and supply chain management (O.S.C.M.), which requires rethinking and changing the mindset of how products are manufactured and services are used" (Caiado et al., 2022, p. 1), it is important to take into consideration its challenges and benefits.

The main problems regarding Industry 4.0 in healthcare are patient intimacy and cybersecurity. People often don't choose strong passwords or accidentally share sensitive information about their health online. These devices are connected to the internet and can be hacked. Those often lack security, and the user side represents a vulnerability.

There is also a problem with the connection between specific IoT-based systems and third-party apps. Most applications don't communicate well between themselves or the server, causing several types of disruptions.

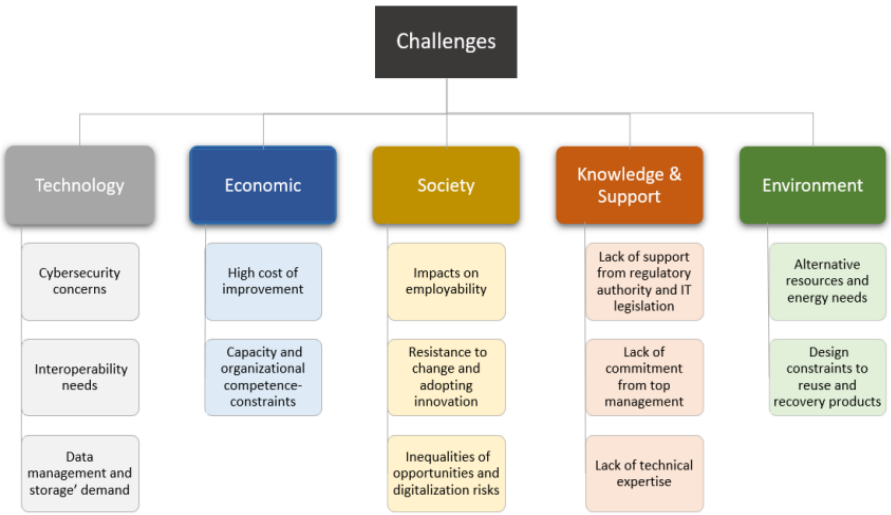

Figure 2.3: Challenges (Caiado et al., 2022, p.10)

At the challenges above, we can also add those coming from the medical field, like the concern regarding the use of 4.0 technology, because it can influence the human relationship in the medical profession, which is the base of medical care. As mentioned in the chapter before, the health sector needs adjustments because of a lot of new challenges like the lack of nurses, the increased and increasing number of patients that need more care, and the complexity of the cases. But the biggest benefit of using 4.0 is that technologies can replace some technical procedures, giving more time to the patient-nurse relationship, like automated IV pumps, portable monitors, smart beds, and wearable devices like mobile phones, which enable nurses to assess, for example, the respiration rate, heart rates more easily. There are also smart houses that enable medical staff to be in contact with the patients, informing them about the status of the person in the house without checking permanently, which can give more dignity and independence to the person in need. And also, the database can collect, through electronic reports, all the procedures needed to be done or are already done, which can help avoid mistakes like forgetting to apply a procedure or a treatment. All these techniques can help better and more discrete monitoring of the person who needs medical support.

But there are more benefits to using 4.0. technologies, and of course, they are impacting the medical field regarding the efficient use of resources, prosperity with fewer costs, and an increase in job quality and workforce capability, as mentioned before.

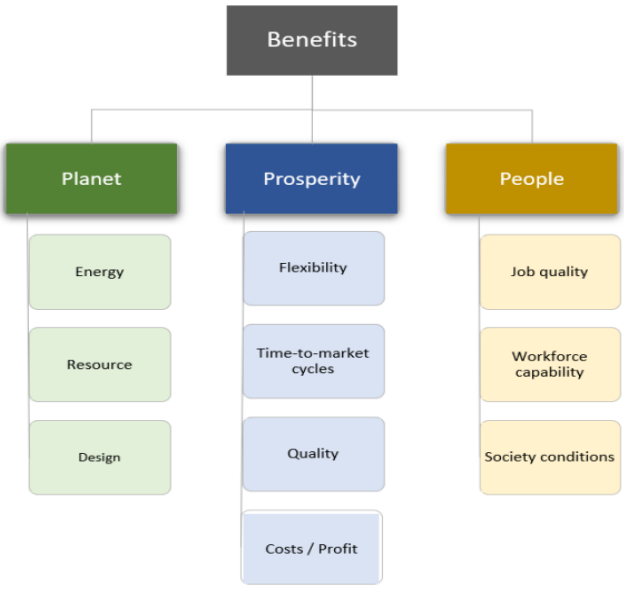

Figure 2.4. Benefits (Caiado et. al., 2022, p. 13)

Regulation is also a problem and will impact both the legal framework of the healthcare sector and the clinical framework, including the role of I.T. and how hospitals can use automation and robotic process automation. The biggest challenge for clinical and I.T. professionals in the healthcare sector is that IoT is disruptive and requires significant training to implement.

For both the hospital and the patient, there is an opportunity to improve their services using IoT technologies, including robotic process automation and other robotic elements.

On the upside, the opportunities for creating innovative new products and services based on IoT solutions and advanced analytics are significant.

The impact on human resources

Each individual needs to adapt to these changes. As we can see in recent articles, A.I. (D.A.L.L.E.) can create digital art with only a couple of explanatory words. Software like Synthesia can generate videos of avatars speaking using text only. Even in the I.T. sector, programs can now write programming code. We don't necessarily need to be afraid of these changes but use them to be more effective. People must think, and robots must work. The World Economic Forum defines advanced cognitive capabilities as the ability of machines to perform human-like reasoning. Companies must embed human skills as an integral component of their digital transformation strategy. This change will happen at a massive level globally, and companies must focus on R&D to stay ahead. There will be greater demand for creative thinking, innovative technologies, and improving internal processes. People who can identify and use these tools and concepts will benefit from an advantage in the marketplace and earn higher salaries.

Many people don't think of economics when it comes to modern technology. But by expanding supply, technology should allow businesses to scale back costs and make their products more affordable for consumers. It is also a way to improve efficiency in the workforce and strengthen relationships with suppliers and consumers.

2.3. The specifics of the field of psychiatric care

Mental health and psychiatric disorders

Mental health is defined, according to WHO, as "a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and can make a contribution to his or her community" (WHO, 2022) and Galderisi et al. (2015) underlie the importance of changing the conceptualization of mental health as the absence of illness which doesn't give a direction on the best way to approach the mental illness. In this sense, people must be seen as persons with good moods and bad moods, sadness, or joy, depending on many aspects of their lives and their personal and social contexts.

Considering the complexity of identifying and treating mental health issues, in order to have a more clear explanation of this concern, a more comprehensive definition was proposed: "mental health is a dynamic state of internal equilibrium which enables individuals to use their abilities in harmony with universal values of society like respect and care for oneself and other living beings; recognition of connectedness between people; respect for the environment; respect for one's own and others' freedom. Basic cognitive and social skills; ability to recognize, express, and modulate one's own emotions, as well as empathize with others; flexibility and ability to cope with adverse life events and function in social roles; and harmonious relationship between body and mind represent important components of mental health which contribute, to varying degrees, to the state of internal equilibrium" (Galdersi et al., 2015, p.1).

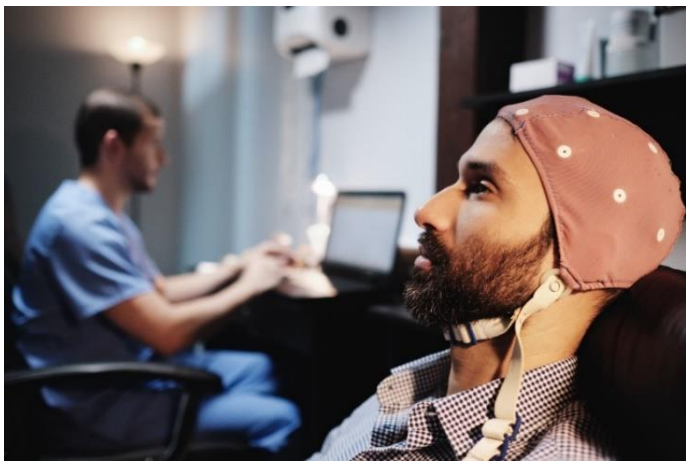

Figure 2.5. Author: engagestock. *Retrieved from:* https://elements.envato.com/health-care-professionals-working-in-hospital-with-XFWSWA8

As a starting point, this definition changes the perspective of illness, but also, the approach of the patient with mental disorders needs adjustment. If classical medicine reduced the patient to a diagnosis, a "service user," which made him a passive recipient of care, modern medicine is focused on "the active participation of the person with lived experience of mental distress in shaping their personal health plan, based on their knowledge of what works best for him/her" (Santos & Cutcliffe, 2018, p.1). With this approach, the nursing process becomes more of a partnership, the caregiver and the patient working together, recognizing the patient as a person with his own values and also the expertise of the patient in his disease and taking into consideration the social context including professional life, familial life, etc. (Santos & Cutcliffe, 2018). What is important here is to notice that this tendency is not encountered only in the

psychiatric field of care but also in the general medical field. These changes come along with the development of medicine, which becomes more and more technical, and it can make it difficult to keep this humanizing medicine tendency focusing on the patient's needs and therefore it is important to understand the specific nursing aspects in psychiatry when thinking about the 4.0 Industry use in this domain.

Personal life and stigma in psychiatric/mental disorders

Raising the level of knowledge and awareness about factors that can lead to mental illness can help in giving a "more nuanced and holistic response to a person's needs" (Santos & Cutcliffe, 2018). Bio-psycho-social model of illness see the effects on the entire life of the person, including her professional and social existence, and this is also the case for psychiatric disorders, which are more at risk for stigma and social exclusion because of the "unseen" and "unknown" and the philosophy behind the care can influence what kind of care nurses can provide being either focused on "specific practices, for example, monitoring symptoms, ensuring medication compliance, tracking response to medication, observing to prevent risk to self and others, and engaging in control and restraint, each of which is practices which are easily detected", attributed to the psychiatric nurses or focused on "moving clients towards more healthy lifestyles when the predominant discourse is biomedical" (Santos & Cutcliffe, 2018).

Mental health nurses and psychiatric nurses

What is called "this awkward conflation of mental health nursing with 'psychiatric nursing'" (Santos & Cutcliffe, 2018) is important when thinking about the use of the 4.0 Industry in psychiatric or mental health care. "'Psychiatric' nurses carry out several defensive, custodial, uncritical, and often iatrogenic practices and treatments, which are based on a false epistemology and misrepresentation of what are, by and large, 'human problems of being' and represent these as so-called mental illnesses (Cutcliffe 2008), whereas those describing themselves as 'mental health nurses can be described as a specialty branch of the discipline of nursing and a specialty craft if you will that operates primarily by working alongside people with mental health problems, helps such individuals and their families find ways of coping with the 'here and now (and past), assists in discovering and ascribing individual meaning to the person's experiences, and explores opportunities for recovery, reclamation, and personal growth—all through the medium of the therapeutic relationship" (Cutcliffe 2008).

The use of 4.0 Industry in psychiatry

4.0 Industry has its impact in the health area on providing care for patients with mental health issues, whether it is about the psychiatric or mental health nursing approach, which can be considered to have direct but also indirect effects. The direct ones refer to the use of 4.0. industry in assessing, monitoring, and treating the patients, while the indirect ones refer to the use of 4.0 Industry in teaching nurses in psychiatry, with influences on the care given to the patients, and also in helping the relatives of the people suffering from mental illness to understand their co-existence with the disease to be more able to be helpful for the patients.

There is a consistent difference if the approach of the caring process is seen as patient-centered and the nurse-patient relationship is more collaborative than when caring is focused on the symptoms when applying 4.0. Industry in psychiatry. Including the service users (a concept that tends to replace the concept of the patient to provide a more humanistic medicine) in the process of decisions is one of the fundamental principles of WHO. However, the difficulties underlined by Santos & Cutcliffe (2018) are still linked to the specific of caring people with mental health difficulties and depend on their legal capacity in giving informed consent, as well as their decision-making process. This has been pointed out as "a major area of developmental work for WHO over the last decade, culminating in the release of a comprehensive set of Quality Rights training and guidance materials for assessing and improving standards of care and human rights protection across different mental healthcare settings and in ways that are fully in line with the U.N. Convention on the Rights of Persons with Disabilities. It is incumbent on mental health nurses to be not only cognizant but also respectful of the human rights of those whom they are caring for" Santos & Cutcliffe (2018, p. 1).

What is also considered to be of interest is the need to overcome the medical model of approaching the service users in psychiatry, seeing beyond a medical diagnosis, using technology to build a relationship based on caring and constructing a context of hope, preventing hopelessness and fears which most of the times accompany the people with mental disorders and their relatives (Santos & Cutcliffe, 2018).

Social life and psychiatric/mental health disorders

Another issue to be mentioned is the family members' involvement in caregiving for people diagnosed with mental illness because, most of the time, the family members are the ones taking day-to-day care, supervising the medication, and overseeing the financial support of the patients. So, what needs to be taken into consideration is the stress and the burden of the family members; finding a way to be supportive and help them find coping strategies to deal with these issues because if they develop unhealthy strategies, this might affect the process of caring for mental health patients. Seen the family as a "key support system" for health professionals underlines the need to take into consideration the social context of mental health people which can contribute to the patient's benefit (Chadda, 2014).

Some of the difficulties associated with mental illness are summarized by Chadda (2014) concerning the person who is suffering, but also the belonging family, and they were labeled as burdens. "A person with mental illness often remains unappreciated, is frequently blamed for his or her problems, and is misunderstood by the general public." (Chadda, 2014, p. 223). They are suffering from social stigma, which brings nonacceptance of the patient by society, social isolation, financial problems, and restrictions of social activities considered to also have effects on the person's health. All these issues mentioned are affecting not only the person suffering from a mental illness but also the whole family, which are, according to the author, the main caregivers, and they are facing the same problems of feeling isolated from society and a lack of understanding and support.

2.4. Benefits of 4.0 Industry for psychiatric patients

The top ten trends in the healthcare sector will be briefly discussed in this material, along with positives and negatives outcomes: IoT (Internet of Medical Things), A.I. (Artificial Intelligence), Telemedicine, mHealth (Mobile Health), Blockchain, Big Data & Analytics, Cloud Computing, 3D Printing, Immersive Technology, Genomics.

Figure 2.6. Author: Wavebreakmedia. *Retrieved from* https://elements.envato.com/mature-african-american-businessman-using-virtual--8DMNUNW

1. **Artificial Intelligence**. Traditional healthcare procedures that require a lot of manual labor and time are being replaced with real-time A.I. solutions that are faster and remote-accessible and have a wide range of utilizations for diagnosis, treatment, and prevention. An increase in the need for therapy has been reported by 84% of psychologists who have worked in treating anxiety disorders since the pandemic started, according to a poll by the American Psychological Association. That is an increase from 74% a year ago. It is becoming more evident the potential to revolutionize the delivery of more individualized and effective treatments through the integration of artificial intelligence (A.I.) into mental health services. The technology helps refine therapist approaches and training in addition to providing more insight into patients' demands. Using A.I., the patients can benefit from the most suitable form of therapy, and therapists but also professionals can track the patient's progress and modify the treatment if necessary. The use of A.I. can improve the patient's well-being by using complementary therapies instead of just taking medication.
2. **Internet of Medical (IoMT).** Enables the creation of products that deliver healthcare services with little to no human interaction. Many applications, like smart diagnosis, and remote patient management, are made possible through building adapted infrastructure and connecting equipment and medical devices. Particular applications of IoT, such as smart home care systems, smart pills, robotics, and RTH (Real-Time Health System), are becoming more common. This technology helps track the patient's condition and response to treatment as well as enhance their quality of life, improving patient-centered healthcare. Due to the specific of care in psychiatry, smart patient monitors are of great help because they can facilitate network processing and communication for real-time diagnosis (Cognitive IoMT-CioMT). Also, motion sensors can monitor the development of Parkinson's disease symptoms, and mood sensors can assist medical professionals in controlling a patient's mental health. Other important

pros of the IoMT are that technology also helps dementia patients interact, communicate, and feel better Nakamura et al. (2021), and by streamlining the dosing procedure and administering IV medication, the IoMT can aid in the prevention of medication errors. Patients who regularly take their medications may benefit from new smart pills and capsules. They are equipped with specialized sensors that react when they come into contact with the stomach acid of a patient. Once the pill has been taken, they communicate with a wearable medical device—such as a patch on the wearer's chest. Abilify Mycite, an antipsychotic drug intended to treat disorders like schizophrenia and bipolar disorder, was the first smart drug approved by the F.D.A. (Food and Drug Administration). Patients with these illnesses may find it difficult to recall when they last took their medication, but skipping a dose can have unfavorable effects, such as nausea, dizziness, anxiety, and a return of the symptoms of the mental health condition. Patients can monitor their medication compliance and evaluate patterns when they take their medications with the aid of the intelligent system. Although smart pills are not yet commonly utilized, they may soon assist patients and healthcare professionals in enhancing prescription adherence and monitoring at-home use. But there are also some cons for the use of IoMT like security and confidentiality risks which should be considered, concerning the collection, transfer, administration and processing of patients' data, GDPR and national/international regulations compliance, patient-care equipment, devices, and services costs and accessibility and also the low level of health and IT literacy of the patient, non-compliance etc.

3. **Telemedicine**. Telemedicine was adopted more quickly because COVID-19 pandemic and is beneficial to underserved populations, especially those living in places without access to psychiatric care. So, mental health services like telepsychiatry proved to be very useful for psychiatric care, a virtual appointment showing to be as effective as a face-to-face consultation for psychiatric and psychosomatic disorders, as well as for evaluating and treating conditions like obsessive-compulsive disorder, depression, or schizophrenia. Here are some brief advantages and disadvantages of online therapy: Pros: escaping the stigma associated with mental illness is crucial for those who live in small communities and value their privacy; the patient may find it challenging to travel because of their health, the distance (accessibility), or simply because of their schedule, therefore online therapy provides accessibility, convenience, and safety—not just during pandemics; compared to an in-office appointment, there is little to no wait time before a virtual appointment; the way the therapy session is conducted depends on the level of security and intimacy present. The patient is in his or her own familiar surroundings rather than a clinical setting, which can make them feel more secure and make it simpler to accept communication with the therapist; the outcomes of in-person visits and video consultations are comparable. But the cons are also important when choosing to apply telemedicine with psychiatric patients because, during the virtual appointment, the therapist might not be able to properly observe the patient's non-verbal communication; for some types of patients, such as children, people on the autism spectrum, patients with dementia, or other types of cognitive issues, the effectiveness may be restricted; some patients might not be comfortable using technology or they might not have access to fast internet or powerful devices; when discussing the drawbacks of virtual therapy, insurance is another factor to consider. In

some circumstances, the health insurance company may only pay for in-person therapy sessions and decline to pay for a virtual session. But also, keeping the patients in their own surroundings, even if that makes them feel more secure, puts the burden of caring more on their family members' shoulders, which can affect the process of the treatment itself if the family does not have the proper support from the medical staff.

4. **Big Data & Analytics**. Refers to the collection and storage of medical data, methods of diagnosis, planning of the treatment, surgical circuits, procedures and protocols, remote consultations, and patient monitoring (Koppe et al., 2021), which are all being transformed by digitization. In the future, it is anticipated that the amount of health and medical data will increase significantly and can improve patient-based services (including remote monitoring, teleconsultation, and e-prescription), detect diseases earlier, generate new insights into disease mechanisms, track the effectiveness of procedures at healthcare facilities and patient satisfaction, as well as enable better treatment methods for patients. But also, there can be mentioned similar difficulties to those in the IoT situation, including patient data security, national/ international regulation, system malfunctions, misconfigurations, product defects, and other issues that may cause delays or negatively affect the current (medical) activity.
5. **Immersive Technology like AR/VR and MR**. It is expanding its use in the healthcare industry, and applications for V.R. in the neuro-psychiatry range from helping with cognitive and physical rehabilitation to exposure therapy and rehabilitation therapy for anxiety disorders. Augmented Reality and Virtual Reality play a significant role in medical education by enabling medical professionals to understand better the signs and symptoms of mental illness and disorders and how patients deal with them. The psychiatric patient benefits from better-trained medical staff in terms of communication, empathy, and quality of care. Numerous factors, including a large number of patients, the lack of facilities with the necessary equipment, the expense of the therapy, which may not be covered by health insurance, travel expenses, and even distance, make it more challenging to obtain access to such technology.
6. **Mobile Health (mHealth).** Mobile health gives access to tailored information (Nicolas et al., 2016). With the help of mobile devices, patients can visualize health issues to prevent illness relapse. Healthcare delivery is made equal and accessible by wearable sensors linked to smartphones, dedicated diagnostic tools, and high-quality medical imaging, which use real-time data streams and are not geographically restricted. The benefits for the patient from a mobile health platform are linked to getting a simplified and better relationship with the caregiver; allowing inside the mobile Health care chain to have optimum traceability for information, sharing prescriptions, diagnostic images, medical certificates, patient consent between professionals can lead to getting a better and faster treatment but also complex monitoring of the treatment efficiency and the patient compliance; and also offering an interface for communication between physicians and patients (by telemedicine). Many applications for mental health can be found by consumers through app stores, but there is no evidence of effectiveness. The actual enthusiasm of consumers for apps represents a chance to increase willingness to help and access for psychiatric patients. Still, before this opportunity can be valorized, it is vital to develop strategies for disseminating information about app quality. In

practice, consumers could be informed about these apps from the developers of consumer-used tools or from portals on app accreditation (Nicolas et al., 2016)

7. **3D Printing**. 3D printing used for printing bionics and lightweight prosthetics could help psychiatric patients by treating various brain diseases and disorders as well as healing head injuries using stem cells to print brain tissue and study the human brain. The aim is to treat illnesses like schizophrenia, epilepsy, and perhaps even Alzheimer's disease, which cannot be studied using animals. The study of new uses for 3D printed pharmaceuticals, initiated by pharma producers such as Triastek, a Chinese pharmaceutical additive manufacturing (AM) company, and Eli Lilly, is another application of 3D printing that is of interest to the entire medical community.
8. **Blockchain technology**. This technology is suitable for various applications in the healthcare sector due to its security and traceability. Remote monitoring of the patient, electronic medical records, pharmaceutical/ medical supply networks, and health insurance complaints and requests are a few of these. Fast Health Interoperability Records and E.H.R. management for clinical data sharing are both supported by blockchain technology. Additionally, it is crucial for smart contracts, combating drug counterfeiting, and storing, sharing, and retrieving digitally gathered biomedical data. A French startup called Blockpharma creates anti-counterfeiting and drug traceability systems based on the blockchain. Patients can use the app to quickly verify the legitimacy of the drug box. When a lab discovers a fake pharmaceutical, it immediately notifies the startup, which then adds the drug to its "black" list. Other pharmaceutical companies developed online platforms to link patients with severe, occasionally persistent conditions (such as Crohn's disease, anxiety, depression, and more) with medical professionals for video or teleconsultations and medicine suppliers (e-prescriptions and medicine delivery). Making healthcare more accessible for people and their healthcare providers means enhanced patient care. So the benefits of this technology include increased flexibility and improved access to medical services and information, but the cons are also linked to data privacy and security, which could be at risk of being compromised.
9. **Cloud Computing**. Panner (2021) allows clinicians to design high-quality patient experiences thanks to telemedicine and remote monitoring. Cloud computing eliminates the need for local storage, offering greater storage capabilities and better data analytics processing power. Cloud platforms combine access and identity management with network and security, monitoring, and alerts. Additionally, it offers data management, smart data potential, data backup and recovery, and the interchange of data. The benefits of cloud computing for psychiatric patients are as follows Panner (2021): patients can benefit from on-distance mental health services (Telehealth and remote monitoring) and they can have access to an electronic database with all their medical data; the professionals can have real-time access to patient data, including medical history and that allows clinicians to diagnose and treat patients more accurately. But there are also cons, regarding Panner (2021): difficult access to equipment and technology (Devices, internet), security risks of the system/ of data. G.D.P.R. Compliance, ownership, and management of data (Data entry into clouds is simple, but data exiting them isn't always. Patients also have the right to know who handled their data under HIPAA (The Health Insurance Portability and Accountability

Act). These risks must be considered, and cloud service provider contracts should be carefully reviewed to ensure that a healthcare organization doesn't expose itself to these risks).

10. **Genomics**. Early risk detection would increase people's awareness of their lifestyle choices, enabling them to lead healthier lives (alimentation, mindset, level of physical activity, etc.). The accuracy of the execution and practical recommendations that a genomic test can offer to patients would be ensured by clinicians through the integration of genomic knowledge into currently used clinical procedures and protocols. Even if there are benefits to detecting the genetic predisposition to Alzheimer's or Parkinson's disease, the professionals must be aware of the expense of the tests, which is quite high and not included in standard health insurance. Phosphorous is a US-based startup developing an at-home genetic test using saliva samples to detect diseases that are caused by multiple genes (diseases like infertility, heart disorders, inherited cancers, neurodegenerative disease, etc.). These tests, which are innovative, simpler to use, and more affordable, have yet to be examined for accuracy and safety.

2.5. Take action

Use knowledge acquired to take action	
Action Change Things	There are some devices easy to use like smartwatches which can allow the patients to use apps for measuring some vital signs like BP, ECG, PR the quality of sleep, the level of stress mood trackers and activity which cand give to professional's real time information about the patient. It can be relevant to discuss the utility and relevance of these kind of apps to introduce them as monitoring tools for the psychiatric patients concerning some physiological parameters important in understanding and monitoring the patients by the professionals. Some easy-to-use devices are Mood Tracker Apps (for anxiety, depression, stress management etc.) and there are some examples in the link bellow: https://www.verywellmind.com/best-mood-tracker-apps-5212922.

2.6. Conclusions

In conclusion, Industry 4.0 will affect the entire supply chain, disrupting businesses of all sizes. Instead of outsourcing production, businesses will have to understand the process and find the right expertise and experience to make their products and services. In short, they will have to focus on what makes them different and the benefits that the Fourth Industrial Revolution can offer. We all need to adapt to these changes and use technology to make our work more efficient, develop leadership skills, encourage innovation, and promote flexibility, especially in technology areas.

Considering the pervasive effects of the mental illness, it is crucial to approach the patient to work also with the family who needs support and can contribute to a better recovery of the

person because they are affected in their day-to-day activities like school, work, financial burdens, etc., and they may have to deal with the non-compliance with the treatment of the patients. Being a long-term disease and not knowing too much about how it is going to go, depending on the treatment, there are a lot of emotions and concerns involved for the person with the mental illness and also for the family, which are the main caregivers after the patients are returning back home from the hospital.

In light of analyzing the top 10 trends in the 4.0 Industry, as they apply to psychiatry, there are numerous benefits and some risks for the psychiatric patient to use them in therapy. The benefits are mostly linked to a better diagnosis, treatment, and monitoring of the patient, and the cons are more related to data protection and the risks of losing intimacy, but in the end, the focus should be on increasing the life quality of the psychiatric patients and also of their families.

4.0 Industry in psychiatry can bring more space to the patient-professional relationship by making the diagnosis easier, monitoring the treatment and its efficiency for the patient, and also controlling the impact of the disease depending on the patient's environment, social context, etc.

So, beyond the costs of implementing 4.0 technologies, it might be cheaper in the long-term concerning for the benefit of the professionals in psychiatry but also the benefits of the patient and his family, who are recognized as caregivers next to the professionals.

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3. Health 4.0 impact on mental health jobs

"No mental health professional today can avoid confronting the issues presented by the new technologies"

Marlene M. Maheu

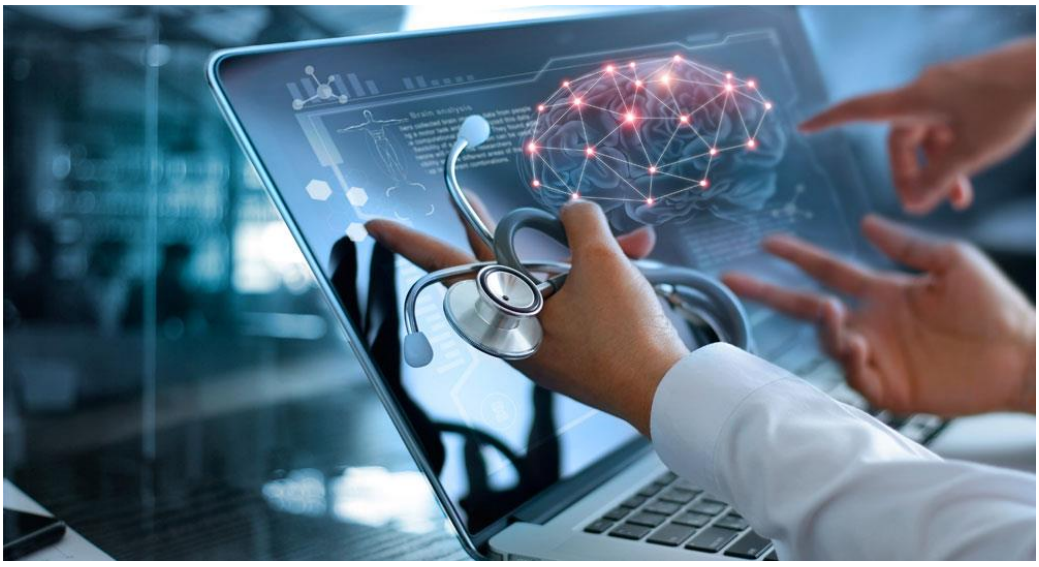

Figure 3.1: New technologies are changing the world in which mental health professionals and their patients live Source: 42Gears Mobility Systems Retrieved from: https://www.42gears.com/blog/healthcare-4-0-five-trends-you-need-to-know/

3.1. Introduction

The information revolution that is developing in parallel to Industry 4.0 has led to a radical transformation of the world to which we are accustomed. Today, a big part of production and management processes wouldn't be possible without the support of Information and Communication Technology (ICT in short).

And, in the last years, many technologies deriving from the industrial sector, specially the so-called 'Industry 4.0' technologies, started to sharply change the environment in which both mental health professionals and their patients live. In fact, as the concept of digital transformation is gaining momentum in all areas of life daily, revolutionizing the way we produce and interact, the applications of digital technologies tend to "specialize" in the individual sectors of application. Thanks to new solutions and to the application of digital technologies, from the IoT to the Artificial Intelligence, also mental health care evolved into what we call Health 4.0. At the same time, the pandemic has opened up new opportunities and has proved to be a crucial factor for the integration of digital technologies into mental health support.

The evolution of computing science today sees the connection through the Internet of an increasing number of equipment and smart devices while computing power continues to grow and cloud computing makes possible the provision of new distributed information services.

In particular, the potential of the new technologies in mental health care is to make solutions offered to patients more accessible, acceptable, and adaptable to special needs. No mental health professional today can avoid confronting with the new issues presented by Health 4.0.

At the same time, mental health care will become more and more customized, progressively abandoning standard solutions. And technology will change expectations of the mental health workforce and the way that it is educated and trained.

3.2. From Health Care 1.0 to Health Care 4.0

Health care systems share many features with manufacturing systems and, like manufacturing, health care delivery has experienced a long history of evolution. Therefore, considering the evolution from Industry 1.0 to 4.0, we can describe similar multiple stages to represent the evolution from Health Care 1.0 to Health Care 4.0.

Health Care 1.0 refers to the basic patient-clinician encounter, when a patient visits a clinic and meets with a physician. The clinician provides prescriptions and a care plan for treating a disease.

During the years, many new medical equipment and devices have been developed and introduced thanks to major development in health and life science: imaging equipment, monitoring devices, and surgical and life support equipment are increasingly used to support diagnosis and treatment. We refer to this development as Health Care 2.0.

In parallel with the development of IT systems, electronic health or medical record have been implemented to manage care of patients, with a major impact on clinical and operational processes. Many manual processes have been digitalized and remote care and tele-health have become possible using computer networks. At the same time, electronic visits are beginning to replace some face-to-face encounter. This revolution is categorized as Health Care 3.0.

To-day, in the era of Industry 4.0, the health care delivery process can be supported by the Internet of Things (IoT), smart sensors, radiofrequency identification (RFID) systems, wearables, new apps, specialized robots, etc., integrated with cloud computing and decision support techniques that allow a smart and interconnected health care delivery to be achieved. Using Artificial Intelligence techniques, it is possible to envision an enhanced patient-centered care, leading to the paradigm of Health Care 4.0.

In the evolution from Health Care 1.0 to Health Care 4.0, health care delivery developed from simple medication to more complex and smart disease treatment. In the past, patient care was primarily delivered through interactions with a single clinician, and then expanded by including multiple clinicians. Now patient care involves large networks of clinicians and other actors, supported by the right technologies.

The value of mental health technologies is nothing new. In fact, it has long been recognized through the first self-help Internet sites, digital systems of cognitive-behavioral therapy or virtual reality systems for exposure anxiety in the treatment of anxiety disorders. However, most

people in the world with a mental health disorder do not receive any treatment, and among the people who actually receive treatment, there are few who undergo effective treatment. Moreover, inadequate treatment of mental disorders is unfortunately still very frequent today.

Similar to the evolution that led to Industry 4.0, Health Care 4.0 includes increasing automation. The most distinctive and critical difference between Industry 4.0 and Health Care 4.0 is about people engagement: in Health Care 4.0, patients and clinicians are increasingly involved and share responsibilities for monitoring their health, reporting symptoms, and participating in shared decision making for treatment and care planning.

In other terms, in Industry 4.0, the participation of people becomes less significant along with increasing automation. However, in Health Care 4.0, with more automation and use of technology, the participation and importance of people become more critical. Not only patients, clinicians, and supporting staff are included in the system, but also their responsibilities are increasing. At the same time, the use of digital technologies such as computers, tablets, smartphones allow the creation of programs/ interventions to promote mental health in "digital" mode that are more accessible, easily exportable, and adaptable/ modular, aimed at all groups of the population.

One example is concerning telepsychiatry. Research has shown that telepsychiatry based on video calling is a form of service delivery that allows valid assistance to those suffering from mental illness and promotes high levels of patient satisfaction. The range of services offered by telepsychiatry based on video call, the potential users and delivery points of these services are theoretically unlimited.

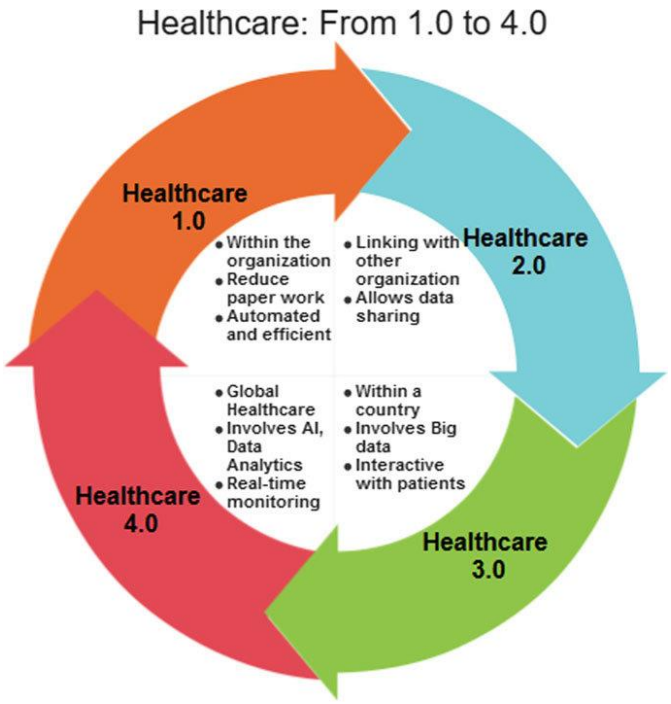

Figure 3.2: The evolution from Health Care 1.0 to Health Care 4.0
Source: Importance of Fog Computing in Healthcare 4.0 Retrieved from:
https://www.researchgate.net/figure/From-Healthcare-10-to-Healthcare-40_fig1_343382201

3.3. Examples of Industry 4.0 technologies being used in Healthcare 4.0

Industry 4.0 technologies applied to healthcare reduced time, costs, and led to the implementation of better solutions. In fact, Health Care 4.0 technologies enable to make the healthcare sector more straightforward than before; for example, improving and enabling remote monitoring systems based on the Internet of Things (IoT). The Internet of Things is a highly promising family of technologies which can offer many solutions towards the modernization of Health Care.

IoT refers to a world-wide network of interconnected heterogeneous objects that are uniquely addressable and are based on standard communication protocols. These include sensors, actuators, smart devices, RFID tags, embedded computers, mobile devices, etc. The structure of IoT is based on three layers; namely, the perception layer (sensing), the network layer (data transfer), and the application layer (data storage and manipulation). Despite great improvements, IoT is still evolving, trying to obtain its final shape as the term "Internet" implies, networking capability is one of the core features of the IoT devices.

In the healthcare sector, the patients can monitor themselves and collect data then, with the help of IoT devices, the data can be electronically transmitted to physicians. Data include health indicators, blood level, heart rate, and much more. In particular, the Remote Patient Monitoring (RPM) allows doctors to know what is happening to a patient without being physically present. RPM offers many benefits, including improved patient outcomes, faster response times, and significant cost savings over time. In fact, RPM integrates telemedicine, reducing the need for patients to travel and decreasing the risks for everyone.

Transferring data from one place to another is another advantage of Industry 4.0 technologies and with the help of such technologies healthcare support can be provided instantly. By using a wireless system, IoT saves the time and effort of medical staff.

Another technology coming from Industry 4.0 is the Artificial Intelligence (AI). AI is helping doctors to spot mental illness earlier and to make more accurate choices in treatment plans. Artificial intelligence allows machines to model, and even improve upon, the capabilities of the human mind.

A specific application where AI is improving mental health therapy is wearable technologies, that therapists are using technologies to determine ways to improve treatment. For example, mental healthcare providers can monitor a patient's sleep patterns to give accurate reports. The long-term efficacy of AI in mental health therapy is yet to be thoroughly tested, but the initial results appear promising. While the use of AI within the mental health ecosystem offers new opportunities, it also opens the potential for misuse.

Immersive Virtual Reality (VR) technology has huge potential to transform the way that we train healthcare staff. In busy hospital environments, it's near impossible to dedicate the time and resources that are needed to deliver effective upskilling programs, but recent innovations in VR tech have the potential to offer a very impactful solution.

A major advantage is the scalability of the technology, and the potential to reach more of the workforce with lower cost, experiential training. Having this training placed on wards allows staff

to access learning at their own convenience. Workplace based training takes the training out of the classroom and directly to the learners.

Cloud Computing is a well-established paradigm for building service-centric systems. However, ultra-low latency, high bandwidth, security, and real-time analytics are limitations in Cloud Computing when analyzing and providing results for a large amount of data. Fog and Edge Computing offer solutions to the limitations of Cloud Computing.

The term "Cloud Computing" was first used by Google and Amazon in 2006. More recently, Cloud has been defined as a computing paradigm for providing anything as a service such that the services are virtualized, pooled, shared, and can be provisioned and released rapidly with minimal management effort.

Fog Computing is a highly virtualized platform that provides compute, storage, and networking services between end devices and traditional Cloud Computing data centers, typically, but not exclusively located at the edge of network. Thus, the user's computation demand is served at their proximity rather than performing it in the distance Cloud. Moreover, Fog Computing is primarily introduced for applications that need real-time processing with low latency.

Edge Computing is an emerging area where data processing occurs near proximity to mobile devices or sensors. It has been proposed to improve the performance and overcome problems of Cloud by providing data processing and storage ability at the end devices locally. Edge Computing refers to the enabling technologies allowing computation to be performed at the Edge of the network, on downstream data on behalf of Cloud services and upstream data on behalf of IoT services. The distinguishing characteristics of Edge Computing from Cloud are dense geographical distribution, mobility support, location awareness, proximity, low latency, context-awareness, and heterogeneity.

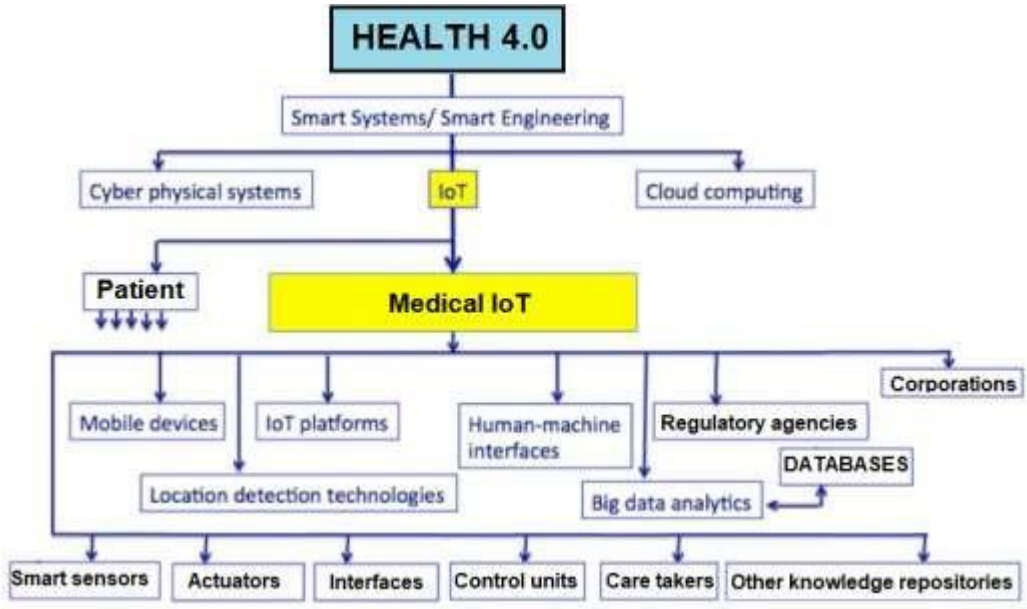

Figure 3.3: The role of Industry 4.0 in healthcare is extraordinary
Source: Health 4.0: Applications, Management, Technologies and Review Retrieved from: https://www.researchgate.net/publication/334634518_Health_40_Applications_Management_Technologies_and_Review

3.4. Healthcare 4.0 and workforce involvement

Given the huge unmet need that exists for mental health services, it is unlikely that technology will reduce demand for mental health professionals in the foreseeable future. The technologies outlined above and the impacts they will have on investigations, interventions and settings of care will, however, change the skills required along with the roles and functions of staff, that will be focused on higher-value tasks.

Health care delivery is about "team" work. Even a standard clinic visit involves many different team members: patients, sometimes caregivers, and multiple clinicians and health care workers, e.g., physicians, nurses, medical assistants, pharmacist, lab technicians, etc. Multiple

processes can be involved as well, such as patient visit process, caregiver work process, information management process, document, and billing process, etc.

Such teams and processes expand rapidly when the system becomes larger; therefore, including outreach to other organizations, the community, various social networks, and expanding the physical boundaries of the system.

Health Care 4.0 provides numerous opportunities and challenges. Humans, including patients, caregivers, and health care workers, should be at the center of smart and connected health care, in both research and practice. It is important to consider their characteristics, needs, abilities and constraints when designing and implementing smart and interconnected health care.

Not only the health community, but also other parts of society will be involved in Health Care 4.0. For example, the COVID-19 pandemic has affected everyone and all the businesses, industries, and communities.

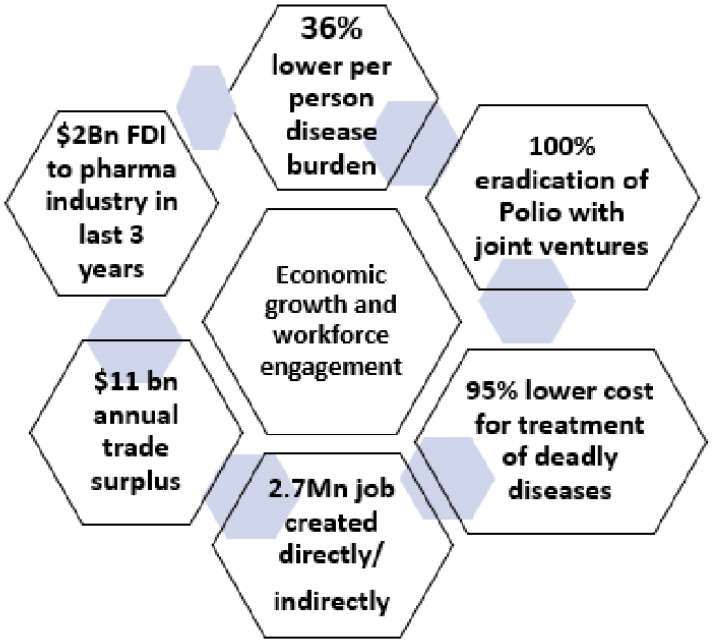

Figure 3.4: It is unlikely that technology will reduce demand for mental health professionals

Source: Building Healthcare 4.0 with Smart Workforce Retrieved from: https://www.researchgate.net/figure/Economic-growth-and-workforce-engagement-Source-Authors-own_fig1_348638364

3.5. Impact on the roles, functions, and skills of the mental health workforce

Given the rapidly changing nature of business, it is necessary to accept the fact of the need to adopt and introduce changes in the organization. Change management is becoming an essential part of the human resources as organizations need to keep up with the new, emerging era of digitization.

Staff at every tier could be supported to care for more complex patients. Throughout the system, time can be released for staff to provide higher value care. If entire services and pathways are reimagined around technology that is co-designed with clinicians and patients, then significantly greater amounts of time are likely to be released.

While technology may provide new interventions for mental health difficulties, patients will continue to seek a human clinician who can empathize and help them to make sense of their experiences. Emotional intelligence will therefore continue to be of central importance for clinicians in the digitally enabled mental healthcare of the future.

Until now, technology has largely been dropped into mental health services to replace an existing part of the care or administrative process. Increasingly, pathways of care will need to be re-imagined around new technological capabilities, such that some functions will be undertaken by other professionals or not at all. Some administrative roles will be automated, and low-value work, such as typing and diary management, will eventually be taken away from highly skilled staff through smart automation.

Despite the development of increasingly advanced sensors, people will continue to be more sensitive than any sensor within mental healthcare. Technology will enable them to record insights more easily and accurately into the mental state of their patients.

It will also become possible for the network of caregivers (family, friends, school, etc.) around the patient to become more engaged and even to become part of a broader but more integrated care team. This could aid recovery and help to identify potential relapses earlier. It would involve a complex flow of information between patients, mental health services and caregivers that will have to be carefully managed by the clinical team.

The multidisciplinary team will contain new roles. There will be a need for clinicians who can interface with technical staff to ensure that products and services support care. There will

increasingly be a need for such skills within individual teams. There will also be a need for staff that can support clinicians and patients in their use of technology, as well as provide analytical support to make use of increasing flows of data.

Technical awareness will be required across the mental health workforce. The rapid evolution of some technologies will make it more practical to provide trainees with broad frameworks or principles, rather than in-depth experience of using particular products.

It is unrealistic to expect large numbers of clinicians to develop skills such as coding or IT support. If technology does not become more usable, then it will not be used.

Mental health professionals will require the same skill categories as today, but the content of those skills and the context in which they are applied will change. The impact of technology on knowledge and skills will spread across the domains of communication, personal and people development, health, safety and security, service improvement, quality, equality, and diversity.

Over the next years, a multi-system effort will be required to ensure that health professionals have the appropriate level of literacy regarding new technological developments. In particular, they need to be able to appraise the quality of products and the evidence related to apps and select the right tool for the right symptoms.

Finally, the core of communication in mental health care is, and should remain, empathy and compassion, regardless of technological change. Managing to sustain these qualities across new digital channels will be a challenge. Staff will need to develop the right skills.

As communication develops across new modalities, for example, through shared VR, there will be new possibilities for richer communication at a distance.

Technological changes should be carefully planned in light of accurate job and task analysis processes, in order to increase the likelihood of a higher Task-Technology Fit. This would increase the perception that the technology in use is what operators need to perform their job in the best way. Regarding staff training, the adoption of new technologies should be preceded by adequate training opportunities which should promote perceptions of their usefulness and ease of use.

Figure 3.5: Staff at every tier can be supported to care for more complex patients
Source: Plugging healthcare workers into the digital future Retrieved from:
https://home.kpmg/xx/en/home/insights/2022/01/plugging-healthcare-workers-into-the-digital-future.html

3.6. New technical awareness

When it comes to digitalization and mental health, there is an underlying bias, which consists in the conception of a system (operator) that delivers the service / treatment with the use of technological tools and a system (patient) that receives it.

In view of the evidence of effectiveness and the optimization of resources that digitalization entails, in order to achieve a real and desirable innovation in the interaction with the patient and amplify the achievable benefits, the approach to the use of technology must be fully

revisited. New technical awareness will be required across the mental health workforce; however, if technology does not become more usable, then it will not be used.

Mental health professionals will require the same skill categories as today, but the content of those skills and the context in which they are applied will change, concerning communication skills, personal and people development, health, safety and security, service improvement and clinical effectiveness.

Digital technologies have the potential to improve the working lives of mental health staff. But if they are not carefully designed, they can also lead to an increased administrative burden, increased expectation, burnout, and isolation.

In particular, the use of AI offers enormous opportunities to modify the organizational structure of psychiatric territorial services and implement important changes in the psychiatrist-user relationship (digitalization of mental health), favoring the movement of the latter towards full empowerment in the care process. This has implications in the medical-legal field which require the development of adequate information and training courses aimed at the correct management and use of new technologies.

Although there are numerous research works that have investigated how new technologies can be an aid in monitoring the state of health of patients, in the management of forms of chronic diseases and in prevention, far fewer have been, however, the research works that have investigated how available technologies can be used in the treatment of people with mental illness.

But digitally enabled care is to become mainstream. This means more online consultations, along with remote monitoring, smart homes, decision support, prediction, and virtual and augmented reality. More comprehensive electronic health records and personal health records and greater linkage of data promise to enable the redesign of care pathways.

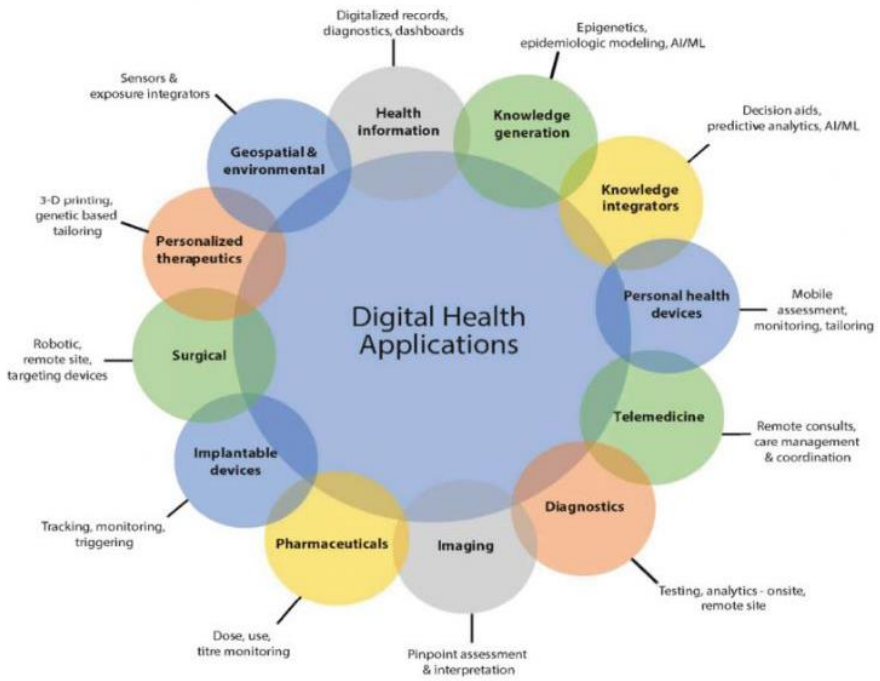

Figure 3.6: New technical awareness will be required across the mental health workforce
Source: The Promise of Digital Health: Then, Now, and the Future Retrieved from: https://nam.edu/the-promise-of-digital-health-then-now-and-the-future/

It is critical to address the issue of disparities and inequities and ensure that Health Care 4.0 is designed to mitigate and reduce such inequities and allow all individuals access to high-quality, safe care. Moreover, the potential negative impact of technologies on sociotechnical systems, like the digital divide, should be addressed, which might need efforts from the public health sector and increased recognition of the role of social determinants of health

Technology that once caused frustration and burnout is now expected to free staff from wasted time and irritating tasks. Systems must be designed with well-trained patients, caregivers, and clinicians to ensure that they are usable and effective.

For the management of mental health, in the near future, it will be necessary to promote and relaunch territorial assistance, take the community as a reference, protect human rights and especially the dignity of people with mental suffering promoting, wherever possible, inclusive care aimed at improving the quality and safety of the services offered for the benefit of patients and operators.

Figure 3.7: The skills required are likely to change and staff will be focused on higher-value tasks
Source: Industry 4.0 and Health: Internet of Things, Big Data, and Cloud Computing for Healthcare 4.0 Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S2452414X19300135

3.7. Take action

Use knowledge acquired to take action	
	Here are six easy brain exercises you can do on your own: 1. Perform Mathematical Gymnastics 2. Use Visualization Techniques 3. Write down the most meaningful thing of the past 24 hours each day 4. Word puzzles, Sudoku, and brain-training apps like Personal Zen and Fit Brains are excellent tools for exercising your brain 5. Do Jigsaw Puzzles 6. Read Thought-provoking Books

3.8. Conclusions

We are living the fourth health care revolution, where the health care delivery process becomes a cyber-physical system equipped by IoT, RFID, wearables, and all kinds of medical devices, smart sensors, medical robots, etc., which are integrated with cloud computing, big data analysis, Artificial Intelligence, and decision support techniques to achieve smart and interconnected health care delivery. In such a system, not only the health care organizations and facilities are connected; but also all the equipment and devices, as well as the patients' home and communities are linked together.

Wearables, in particular, allow to detect specific mental health conditions through changes in the body, through the use of accelerometers, heart rate sensors, sleep detectors, skin conductance sensors and light sensors. The European AffecTech project has conceived a series of wearable technologies that not only have the task of alerting, but also allow effective countermeasures to be taken when an episode occurs.

Everyday technologies have become more and more powerful: our smartphones or smartwatches can record, for example, biological data linked to our emotional experiences, which is very promising for affective disorders. We just need to find ways to go beyond monitoring emotional responses to actively managing them.

At the same time, technology has changed human physiology: it makes us think, feel, and dream differently; it affects our memory, attention, and sleep cycles. All this thanks to brain neuroplasticity, i.e., the brain's ability to change its behavior based on new experiences.

The most distinctive and critical difference between Industry 4.0 and Health Care 4.0 is about people engagement. In Health Care 4.0, patients (and caregivers) and clinicians are increasingly involved and share responsibilities for monitoring their health, reporting symptoms, and participating in shared decision making for treatment and care planning. As they play more significant roles, patients (and caregivers), as well as clinicians, will be at the center of HealthCare 4.0.

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Wellteq 6 easy brain exercises to improve mental wellness

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4. Health 4.0 technologies relevant for the mental health sector

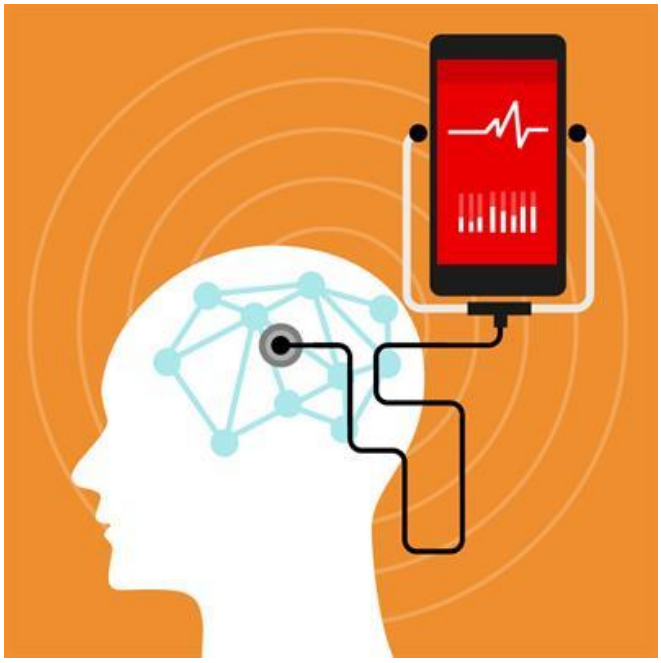

Figure 4.1: m-health and e-health Interventions in Mental Health (www.frontiersin.org)

4.1. Introduction

Digital tools for mental health are aimed at anyone wishing to improve their well-being or in need of care or support in case of psychological disorders or suffering.

Used at the initiative of the person or for a relative, these tools can also be prescribed or advised as a complement to care and support. The increasing development of digital technology in daily life over the last twenty years represents a major evolution that affects our modes of communication, our social relations, our thinking, and our actions.

The use of screens, the Internet and the various digital tools that are almost omnipresent in our daily activities have transformed our activities considerably. Children and teenagers, who are particularly adept at learning about these innovative technologies, have appropriated them for their exchanges, their leisure activities, and then, more and more, for their learning and cultural training, to the point where parents often appear helpless in the face of such change.

This growing trend in the use of digital technologies also impacts the lives of people with Autism Spectrum Disorders (ASD), their families, their caregivers and their teachers.

Among the many possibilities, digital technologies can be used to improve the daily lives of people with autism and help them cope with societal constraints. Also, many concrete digital solutions are proposed by professionals but also by families, educators, and institutions to meet the challenges faced by people with ASD and their entourage.

The use of digital technology with people with mental disabilities, such as autism or pervasive developmental disorders (PDD), covers many areas, including assistance with basic learning and independence. Faced with difficulties limiting autonomy and inter-individual relations, adapted and personalized methods and tools are proposed to promote the independence and social participation of these people.

Whether they are applications on tactile tablets or virtual or augmented environments, these digital tools constitute a real lever in compensating for the difficulties encountered on a daily basis, despite the potential difficulties of generalizing learning.

4.2. Mental Health

According to the World Health Organization, mental health is a general state of physical and mental well-being, not necessarily the absence of disability. We cannot talk about health without mental health. Mental health allows people to build themselves up, to overcome the difficulties of everyday life, to do a job and to build their personal project in their society and community. Mental health is variable over time, depending on the difficulties and events that people encounter in life, and their energy to face these difficulties.

A very good mental health allows people to build themselves, to face the classic difficulties of life, to realize a positive work and to contribute positively to the life of its human society.

Mental health in its positive sense is a state of being that will allow us to think positively, and to take actions in such a way as to improve our ability to derive pleasure from life and to overcome the obstacles and challenges that we face.

Mental health is a broad concept, encompassing well-being and protection from psychiatric disorders. For this reason, many individuals can contribute to the mental health of children. Especially, the parents who participate in their education, the family, without forgetting the education professionals notably the teachers and the animators.

Figure 4.2: The importance of mental health (source : https://www.doconline.com)

4.3. M-health

Mobile health or m-health includes medical and public health practices supported by mobile devices, such as cell phones, Personal Digital Assistants (PDAs) and other wireless devices. The rapid expansion of the "mobile health" sector makes it difficult for users to choose, or for professionals to advise them on choosing the right application.

M-health allows, for example, the reminder of appointments by SMS, mobile telemedicine, the sending of prevention message or follow-up messages on a Smart-phone, etc. prevention messages and medication schedules on Smart-phones. The reference to mobile devices implies not only the use of the mobile phone, but also, more broadly, all wireless technology, and also connected objects. Nevertheless, it is important to distinguish between connected objects and mobile applications, because if the connected object is linked to an application within the mobile phone, they are nevertheless two different elements. Connected objects are devices connected to the Internet that can collect, store, process and distribute data or perform specific actions based on the information received. Connected objects can nevertheless be presented as any instrument, device, equipment used alone or in combination, including accessories and software; equipped with sensors and connectivity systems; communicating via a telecommunications network.

Figure 4.3: M-health and its applications (source: https://www.measureevaluation.org/)

One of the mobile applications that can be used in the field of mental health is the geo-location of people. In order to allow a teenager, or a young person with a mental disability, to gain autonomy and to be progressively detached from his companion. We can ask him to move around by equipping him with a mobile phone using the Google geo-location application. His companion can follow his journey in real time. A second solution is to equip him with a connected object such as a connected watch. The term e-health refers to all areas where information and communication technologies are used to support health, as defined by the World Health Organization. Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. This concerns areas such as telemedicine, prevention, home care, remote monitoring of chronic diseases such as diabetes, hypertension, heart failure, electronic medical records as well as applications and home automation. E-health is increasingly seen as a relevant solution to the challenges facing healthcare systems: changing medical demographics, territorial inequalities in access to care, increasing prevalence of chronic diseases, and aging populations and dependency care.

Figure 4.4: Geo-tracking (source: https://www.edcom.fr)

4.4. E-Health

The term e-health refers to all areas where information and communication technologies are used to support health, as defined by the World Health Organization. Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. This concerns areas such as telemedicine, prevention, home care, remote monitoring of chronic diseases such as diabetes, hypertension, heart failure, electronic medical records as well as applications and home automation. E-health is increasingly seen as a relevant solution to the challenges facing healthcare systems: changing medical demographics, territorial inequalities in access to care, increasing prevalence of chronic diseases, and aging populations and dependency care and Disability including mental disability.

The important development of the last two decades, of computer networks, computers, and computer programming languages, especially those related to the development of websites, have allowed e-health to develop in a significant way. This development has accelerated with the Covid 19 pandemic.

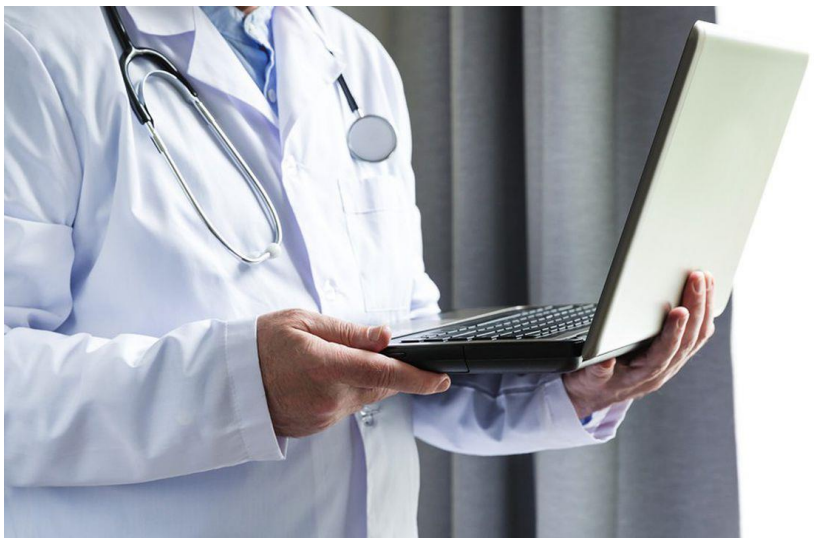

Figure 4.5: e-health through the Internet (source: https://www.lesechos.fr)

E-health serves as a lever to encourage prevention and primary care, while guaranteeing a constitutive principle of the health system and access to quality care for all thanks to a significant network of a territory or country.

One application of e-health in mental health is remote monitoring and remote consultation, particularly concerning the dosage of medication in the event of a change in the patient's condition.

4.5. Telepsychiatry

The crisis generated by the COVID-19 epidemic led public psychiatry to reorganize its prevention system in depth, particularly for patients in confinement. Whether in general psychiatry or in child and adolescent psychiatry, public psychiatry teams have set up PSY/COVID units in a very short time, while maintaining outpatient activity in the Psychiatric Medical Center and taking care to limit the risks of epidemic contagion. Telepsychiatry has also benefited from the important development, during the last two decades, of computer networks, computers and computer programming languages that have allowed the development of powerful browsers equipped with artificial intelligence and also videoconferencing software like Skype, Zoom and Google Meet.

Figure 4.6: Telepsychiatry to solve problems of psychological distress

Telepsychiatry offers:

- Services to maintain one's mental well mental well-being by using meditation exercises, self-measurement of emotions, or the observation of one's daily activities (sleep, stress levels, etc.).
- Support in the face of psychological distress, by offering support for psychological distress, by proposing a contact with a of the family and friends, and emergency numbers, care, or support structures.

There are applications that can be used to improve mental health care, of the thousands of applications available, very few have been the subject of rigorous scientific studies showing their effectiveness and effectiveness and reliability. Moreover, most of them do not guarantee the confidentiality and security of the health data collected. Great care must therefore be taken before using or recommending them.

4.6. Robot therapy

Researchers are currently working on intelligent robots that can learn by themselves and adapt to new situations. They program these robots, thanks to algorithms using knowledge from pedagogy, neurophysiology, and brain sciences. We are in the process of transmitting the human to the robot to make it perform. In order to help children with mental disability to communicate and exchange by using robots. Indeed, these children have difficulties to recognize facial expressions like autistic children. They have difficulty distinguishing fear from a neutral expression. These children may also be unable to appreciate or even react to the feelings or emotions of others, such as pain or distress. This characteristic is common to almost all children with autism and often prevents them from forming friendships. These children may have difficulty with social relationships that require them to understand that others may know things other than they do or have different thoughts from them. This may explain why these children or teens generally have difficulty understanding the feelings of others.

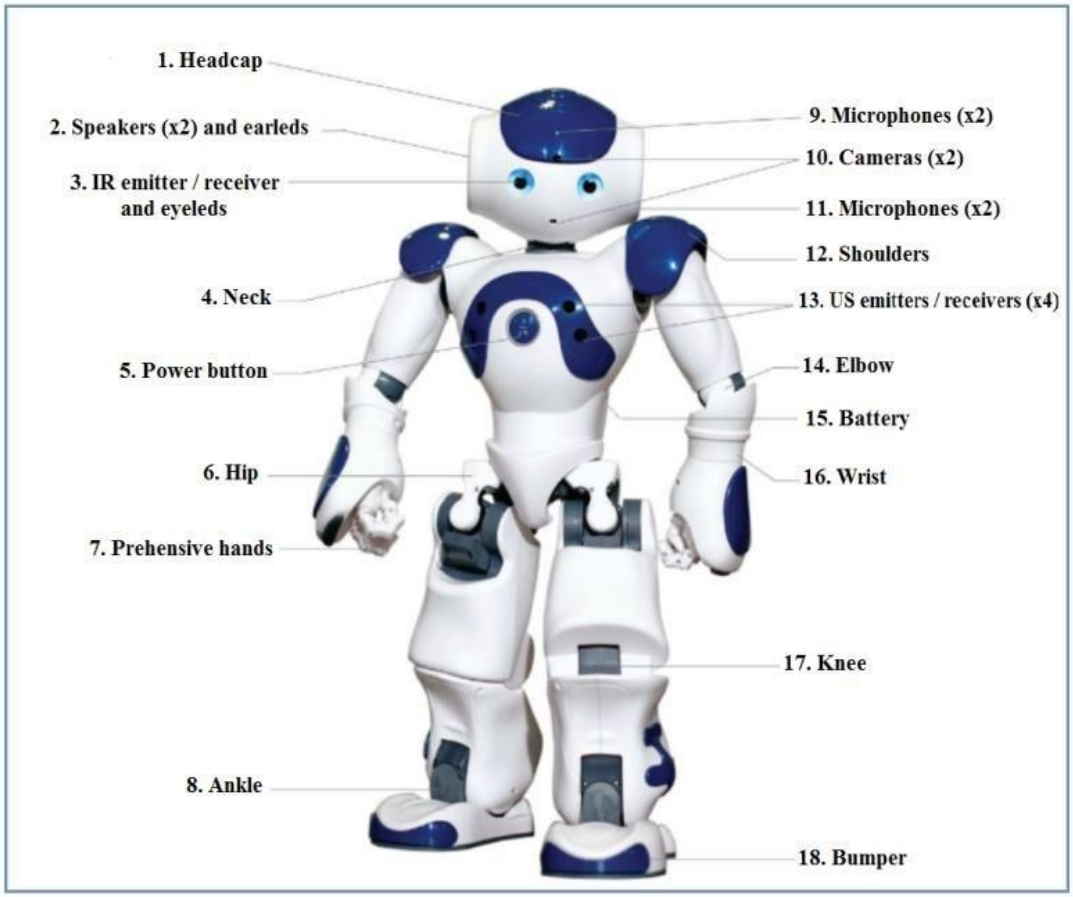

Figure 4.7: The structure of NAO robot (https://www.researchgate.net/figure/Nao-robot-NAO)

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To help these children develop the ability to recognize expressions and form social bonds with children their own age. We propose to develop a robot. Indeed, human behavior is complex and very rich in information (verbal, gestural). This complexity does not help autistic children to understand it. The use of a robot will allow us to simplify this behavior and make it predictable and also to repeat it without getting tired.

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To help the autistic child to speak and pronounce simple words: daddy, mommy, balloon, ...etc. The robot is programmed to verbally imitate any person who comes in front of it and pronounce sounds or words. The imitation of sounds by the robot will motivate the child to make sounds and later words. At first, the sounds or words spoken by the child will be difficult to understand. A long period of learning is necessary for the child to find an understandable pronunciation.

One of the most used robots is the NAO robot. NAO is a French humanoid robot, autonomous and programmable, initially developed by the company Aldebaran Robotics.

Figure 4.8: An autistic child imitating the movements of the NAO robot at the hospital (source :www.aldebaran.com)

4.7. Take action

Use knowledge acquired to take action	
Action Change Things	Look for examples of the following technologies in the literature related to mental health: M-health, e-health, telepsychiatry, and robot therapy. What are the benefits of using these technologies?

4.8. Conclusions

The applications of digital tools in the field of mental health are becoming more and more important. This requires investments in terms of computer equipment but especially in training. The use of robots has intensified in recent years in the mental health sector for socialization and communication but also for learning.

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5. The future of Health 4.0 in the mental health sector

"The best way to predict the future is to create it".

Peter Drucker

Figure 5.1: Future of Health 4.0 in the mental health sector
Source: Gerd Altmann from Pixabay

5.1. Introduction

Health 4.0 is providing a new promising vision for the mental healthcare industry. It enables the introduction of smart, autonomous, and enhanced healthcare services and improves the interactions across the patients, mental healthcare professionals, infrastructure, stakeholders, etc. This has the potential to increase patients' satisfaction while greatly improving the quality, cost-effectiveness, and reliability of mental healthcare services.

The Health 4.0 underlying technologies such as Virtual Reality, Artificial Intelligence (AI), Internet of Things (IoT), and Big Data are continuously improving and they will deliver new applications and tools for the mental healthcare. They have the potential to transform the sector by connecting patients, services, and data in innovative ways, by providing greater access to information and services for patients and by improving healthcare services.

Health 4.0 is revolutionizing the mental health support, patient monitoring, medical data collection and analytics, and other medical processes. It will continue to do so in the future, creating new ways to access medical help, monitor progress, and increase understanding of mental wellbeing.

5.2. The future of health 4.0

The future of Health 4.0 in the mental health sector is inextricably linked with the future of health in general, so it is useful to recognize the trends shaping the later one. This section will present a vision of the healthcare in order to provide a framework useful for understanding the future trends specific to mental healthcare.

According to a study conducted by PwC (Solbach, Grünewald , Wieber, & Schwärzler, 2021) on 150 senior healthcare executives, in 2021, we are at the beginning of an accelerate transformation of the healthcare sector. There is a general belief that by 2035 the healthcare will be personalized, digitized, focused on prevention, centered on human needs, and with health solutions integrated into everyday life.

It is expected that the future of health, in general, and the future of mental health, will be shaped by the digital transformation made possible by Health 4.0 technologies advancements, totally interoperable data and secure platforms.

Nowadays, we can see a wide spectrum of innovations taking place in healthcare, both physical, digital and hybrid. These are interacting in various ways and accelerate the change of the sector. The innovation will enable healthcare to focus on sustaining well-being and on prevention and early diagnoses, rather than responding to illness.

Digital innovations are increasingly adopted and new applications will impact the future. They enable measurable health behavior change, early detection and power diagnostics and therapy, especially through the use of Artificial Intelligence. A survey carried out by Roland Berger (Hosseini, Kaltenbach, Kleipass, Neumann, & Rong, 2021) on more than 400 experts demonstrates that digital technologies are going to play a substantial role in prevention, early detection, therapy selection and therapy supervision.

Hybrid products, combining both digital and physical functions, will be more and more available. For example, various gadgets that can be connected to smartphones will be used for home diagnostics and remote patient monitoring. Brain-computer interface, a technology that allows a human brain to communicate to an external device by exchanging signals, will enable the direct control of machines (i.e., a computer, a prothesis or a wheelchair), without the physical constraints of the body.

Although is impossible to completely eliminate disease, the science, data, and technology will enable its earlier identification, the proactive intervention, and the better understanding of its progression (Batra, Betts, & Davis, 2019). It will be possible, in some cases, to delay or eliminate the onset of a disease. At the same time, innovation related to medical interventions and treatments will make them more precise, cheaper, simpler, and less invasive. Many diagnoses as well as healthcare procedures will take place at home, thanks to the advanced tests and tools developed.

The Health 4.0 technologies will help people to sustain their well-being, to have access to comprehensive information regarding their own health and to own their medical data. The people will play a central role in making decisions about their health and well-being and the healthcare will be centered around the patient.

In the end, the transformation of healthcare will affect all the stakeholders. It will bring some challenges but also many opportunities, and it can radically improve the people health while decreasing the healthcare spending and expanding the access to medical services.

Figure 5.2: Future of health
Source: PublicDomainPictures from Pixabay

5.3. Health 4.0 technologies and the future of mental healthcare

There are many factors affecting the future of Health 4.0 in the mental health sector but the development of advanced digital technologies is among the most important ones. This section will discuss some of the crucial Health 4.0 underlying technologies in order to evaluate how could they shape the future of mental health sector.

The adoption of advanced digital technologies, such as Artificial Intelligence (AI), Internet of Things (IoT), Virtual Reality and Big Data can hugely improve the mental healthcare sector in terms of service availability, accessibility and quality, personalization, efficiency and many more. These technologies are continuously improving and they will deliver new applications and tools for the mental healthcare. They have the potential to transform the sector by connecting patients, services, and data in innovative ways, by providing greater access to information and services for patients and by improving healthcare services.

Artificial Intelligence (AI) is already impacting the mental healthcare, being used to improve the accuracy of diagnosis and treatments, to automate various activities, for monitoring patient progress and altering treatment where necessary, to help with the quality control of treatments, therapist techniques development and the training of therapists, etc.

AI research in mental health is still in its infancy, but this technology is a promising tool in the future of mental health. In combination with sensors, electronics and smart phones, AI tools will aid in early detection, evaluation, and treatment of mental illnesses and may possibly help with their prevention. In conjunction with Big Data technologies, AI has many potential uses related with personalization of treatment selection, prognosis, monitoring for degeneration, early detection and prevention of mental health conditions, and even delivery of some treatments

(Rosenfeld, et al., 2021). In addition, AI advances will allow for widely available computing systems with vison, hearing, learning, and reasoning capabilities, thus opening new ways for improving mental healthcare.

In the future, AI could be a game-changer in the mental healthcare, enabling for provision of more effective and personalized treatment plans. It will be crucial for producing a biologically founded re-classification of major psychiatric disorders based on the analysis of vast amounts of data (Di Carlo, et al., 2021).

However, there are some issues that need to be solved in order to wide open the future for AI. Some of the most stringent ones are related to testing for the evaluation of long-term efficacy of AI in mental healthcare and with the mitigation of risks of unethical and malicious uses.

Internet of Things (IoT) has already many applications in mental healthcare and its use will continue to grow in the future. Some future uses are related to better remote patient monitoring, through customized software, devices and different wearables, medical assets monitoring, workflow of patient automation, medical data collection, medication management etc.

The healthcare IoT is also facing some challenges, especially regarding data security and unauthorized access. It is hoped that these will be solved in the near future.

Virtual Reality (VR) has a huge potential in mental healthcare. Its future is inherently linked with the development of the technology in terms of software and hardware as well as with the development of new therapeutic applications. New interfaces will be increasingly adopted, or developed, in order to improve the patient experience and the feedback to the mental healthcare professionals.

Some issues must be solved in order to allow for a larger use of VR in mental health in the future (Lindner, 2021). The effectiveness of VR therapy should be demonstrated by relevant trials, the hardware needs improvements.

Big Data usage in the healthcare sector is still in its infancy (Dash, Shakyawar, Sharma, & Kaushik, 2019) but it is poised to grow at an exponential rate, as it can extract useful information from vast quantities of unstructured data through proper management, analysis and interpretation. In the future Big Data can be a game changer by opening new ways for the modern healthcare. It will be used to predict epidemics, cure disease, to improve the quality of life and avoid preventable deaths.

Big Data in healthcare has unique challenges, especially related to the patient privacy rights, data security, data entry practices, data quality and infrastructure. Efforts are currently made to tackle these challenges and we can hope that all of them will be met in the future.

Figure 5.3: Future of Health 4.0 technologies
Source: Gerd Altmann from Pixabay

5.4. The future of telepsychiatry

Telepsychiatry, a subset of telemedicine, is the process of providing mental healthcare from a distance through technology. Videoconferencing technology is the most used nowadays but some Health 4.0 technology have the potential to change the telepsychiatry in the future. This section will discuss the future of Health 4.0 - supported telepsychiatry.

Health 4.0 has the potential to transform the entire healthcare sector, including also the telepsychiatry. The integration of Health 4.0 with telepsychiatry is already improving the mental healthcare, in various ways. Some examples of such integrations which are likely to be further developed in the future are given below.

- **Remote patient monitoring** with the help of IoT-powered wearables, mobile medical devices, and software solutions. The collected data can be analyzed using Big Data.
- **Mental Health apps** that use AI to analyze the information collected by various sensors, such as the ones of the smartphones, and take action when detect changes in the patient's typical behavior pattern.
- **Expert Systems** based on AI that assist mental health professionals in providing healthcare.
- **Chatbots** powered by AI that can provide real-time assistance to patients
- **Immersive virtual environments** powered by VR technology that can hugely improve the online consultations.
- **Improved diagnostic methods and outcomes** by using Big Data analysis to extract information from contextual data and potentially useful external information, in addition to the limited information available from patients that are not onsite.
- **Tailored treatment** can be provided with the help of AI solutions that can help clinician in diagnosing a patient, work together with other applications to analyze data and find the best possible treatment for any given patient

In the future, the telepsychiatry is expected to evolve with developments in the field of technology, mental care applications and innovative mental healthcare models. The integration of telepsychiatry with Health 4.0 technologies such as AI, VR, Big Data, and mobile apps opens up exciting future perspectives for the enhancement of mental healthcare (Di Carlo, et al., 2021). Its ability to provide a platform for mental healthcare in remote areas and the other benefits offered, combined with the advancements of Health 4.0 technologies, will drive its expansion.

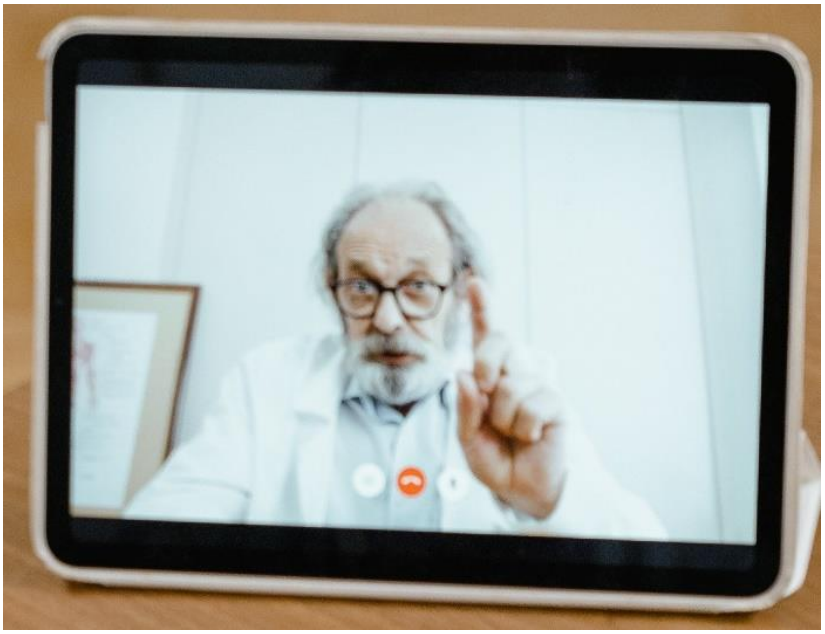

Figure 5.4: Telepsychiatry
Source: Tech Journal from Pixabay

5.5. Future of mental mHealth

The significant mobile internet diffusion and the wide availability of smartphones led to a massive development of Mobile Health (mHealth) which can greatly improve the access to mental healthcare, medication adherence, the patient monitoring and so on. This section will discuss the future of mHealth in conjunction with mental healthcare and Health 4.0.

Smartphones are now a driving force of digital health due to their hardware and software capabilities, reasonable costs for purchasing and running, and widespread. As it is relatively easy to build a smartphone program (called “application” or “app”) and to share it through app stores, there is a massive influx of apps in different fields. The number of mental health apps aiming to improve virtually all known mental health problems increased exponentially (Lecomte, et al., 2020) and we could expect that this trend will continue in the future.

Various Health 4.0 technologies can be integrated with mental health apps in order to further expand their capabilities. For example, IoT-powered wearables can provide data to apps while AI is analyzing the data and diagnose disease without human intervention. Also, Big Data technologies allows to obtain the maximum benefit from mHealth data.

The mental mHealth offers great opportunities but also raises some concerns related to the effectiveness of the specific apps, data privacy, user's guidance, regulation and other. All these need to be solved in order to fully open up the future of mobile mental healthcare.

The future of mHealth in mental healthcare is linked with the evolution of technology (devices, sensors, Health 4.0 solutions for data management and analysis, IT infrastructure), apps (including clinical trials to provide scientific evidence that they are effective), the involvement of all stakeholders, the regulation and standardization. However, given the huge potential of mHealth to transform the future of medical research and mental healthcare, its application and impact are likely to increase in the years to come (Khan & Alotaibi, 2020).

Figure 5.5: mHealth
Source: "mHealth" (CC BY-NC 2.0) by Andy Miah

5.6. Take action

Use knowledge acquired to take action	
Action Change Things	Search your favorite app store using "mental health" keyword. Browse the results and observe the wide variety of addressed mental health problems. Select one app, install it, and test it in order to better understand what a mental app is, how it works and what could be its benefits and drawbacks.

5.7. Conclusions

There is considerable potential of Health 4.0 regarding the enhancement of various healthcare fields, including diagnosis, treatment, service delivery, and research methods. Mental healthcare will also benefit from the digital transformation made possible by Health 4.0 and it is

set to evolve together with the other fields of health and with the relevant technologies, especially AI, VR, IoT and Big Data.

The mental healthcare, including telepsychiatry and mental mHealth, will be more and more integrated with Health 4.0, in order to add new features and to improve the mental healthcare, in multiple ways.

It is important for the mental healthcare professionals to understand how Health 4.0 will revolutionise their sector in order to cope with the changes and prepare themselves for the future. Relevant training, using educational materials like the ones developed in the frame of EUcare4.0 project, is a good way for the mental healthcare professionals to learn about the Health 4.0 and its impact on the future of mental healthcare.

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