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Healthcare 4.0 and Health Management

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Abstract

Industry 4.0, which is rapidly developing and changing in today's world, has also heavily influenced the health sector and is gathered under Health 4.0. This study was conducted to discuss what Health 4.0 applications are and their importance in terms of health management within the scope of their contribution to health services and to make suggestions. In this context, Health 4.0 technologies and applications in the world and in Turkey are first explained. Subsequently, its importance in terms of Health Management was mentioned and suggestions were made. In terms of health management, it can be said that Health 4.0 primarily contributes to accessibility in health services, increases the comprehensiveness of health services, reduces health expenses, and is beneficial in terms of time and effectiveness in accurate diagnosis and treatment. In addition, it was emphasized that studies on the adaptation of health systems, health human resources and society to this rapid change are also important.

Keywords: Health 4.0, Health Management, Health Technologies, Industry 4.0.

INTRODUCTION

Another name for Health 4.0 (Healthcare 4.0) applications is digital health. Digital Health; It is defined as the delivery and facilitation of health and health-related services, including medical care, provider and patient education, health information services, and personal care through telecommunications and digital communications technologies. Live video conferencing, mobile health applications, “store-and-forward” electronic transmission, and remote patient monitoring (RPM) are examples of technologies used in telehealth.

Telemedicine, defined as the use of information and communication technologies to provide clinical healthcare services to remote areas, helps remove the barriers of distance and provides better access to healthcare for people in remote rural areas. It can save lives in some emergency situations (Tezcan, 2016)

Telemedicine technologies not only enable remote communication between physician and patient, but also allow medical images and health information to be sent from one place to another. Today, telemedicine is widely used in home care services (Tezcan, 2016).

Industry 4.0 has emerged in the healthcare industry as Healthcare 4.0. The wave of change that started with Healthcare 1.0, where physicians kept patient records manually, was followed by Health 2.0, where electronic records replaced paper-based manual records. The use of electronic devices in monitoring health status data such as pulse and blood pressure and in medical diagnosis studies is the extreme point reached by Health 3.0. The main technological feature that distinguishes Healthcare 4.0 from its predecessors is defined as the communication of many devices of various types with each other, artificial intelligence and robotic applications (Rehman et al., 2019).

Healthcare 4.0 is a continuous but disruptive transformation process of the entire healthcare value chain, from healthcare and medical equipment production, hospital care, out-of-hospital care, healthcare logistics and wellness environment to financial and social systems. As shown in Figure 1, in Healthcare 4.0, a large number of healthcare devices, including sensors and actuators (e.g. healthcare robots) and services in the physical world (Physical Healthcare Systems-PHS), a large number of digital models in the cyber world (Cyber Healthcare Systems-CHS) and automation processes are fully modeled by PHS to CHS Big Data and CHS to PHS feedback control are transmitted in real time over high-performance IoT networks, and all software components are deployed via Cloud and Fog Computing platforms in a fully distributed manner. Both PHS and CHS are powered by artificial intelligence (AI) not only for data analysis but for all decision-making and execution, minimizing manual intervention. As a result, Healthcare 4.0 will create not only digitalized healthcare products and technologies, but also digitalized healthcare services and businesses (Yang et al., 2020).

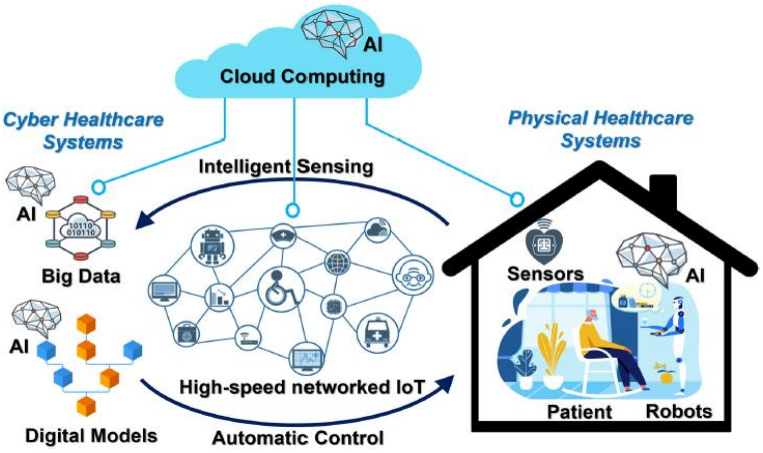

Figure 1. Relationships of Large-Scale Artificial Intelligence-Powered New Technologies in Health 4.0
Source: Yang vd., (2020).

1. HEALTH 4.0 TECHNOLOGIES

Tools and applications that fall within the scope of Health 4.0 and related digital health technologies applications can be classified as follows:

- e-Health,
- Telemedicine,
- M-Health,
- Personalized Health (P-Health),
- Portable technologies,
- 3D technologies,
- Electronic Health Records.

1.1. e-Health

e-Health is a broad term that deals with the use of information and communication technologies in support of health and health-related fields, including health care delivery, health surveillance and education. E-Health can basically be evaluated under three headings:

1. Telemedicine (including disease management services, remote patient monitoring, teleconsultation, home care),
2. Electronic health records,
3. Remote patient monitoring (RPM) (Cowie et al., 2013).

The term m-health (mobile health) based on the concept of mobile devices providing health information such as medication and treatment options, screening patients, monitoring vital signs, providing direct sensors to help facilitate decision-making and delivery of care and patient education and personalized health and social care. and to identify portable micro and nano technologies with “smart” fibers.

The term p-health (personalized health) is also used. Benefits expected from the e-Health system; (Tezcan, 2016).

- More effective disease diagnosis and treatment,
- People who are more concerned with their own health and healthy lifestyles,
- Increasing preventive health activities,
- Tracking and monitoring of chronic diseases,
- A more efficient and sustainable health system,
- Saving time spent on accessing and analyzing information for healthcare professionals,
- It saves costs due to less need for hospitalization.

The basic values of the e-Health concept can be summarized under ten main headings:

1. Productivity: One of the most important effects of e-Health is to increase productivity by reducing wages. The way to reduce fees is to prevent repeated useless diagnoses and treatments by improving communication between healthcare services.
2. Quality Care: E-Health has the ability to compare healthcare institutions. Patients can choose quality organizations that offer better offers.
3. Being Evidence-Based: The validity of e-Health activities has been proven by scientific research.

4. Authorization: Patients can access basic medical information and personal electronic records over the internet with E-Health applications.
5. Transparency: E-Health clearly states what decisions are made in health care services and which treatments will be given.
6. Education: E-Health, online databases and specific preventive information in healthcare support the professional development of healthcare professionals.
7. Activation: E-Health enables health institutions to communicate with each other and exchange standard information.
8. Expansion: E-Health enables consumers to easily obtain healthcare services from global service providers.
9. Ethics: E-Health has brought a new form to the interaction between patients and physicians on ethical issues such as information, confidentiality and equality. New problems remain between patient and physician online.
10. Equality: Making health services fairer for everyone is one of the main goals of the E-Health project (Demirel, 2017).

e-Health can provide innovative solutions that address issues in aging societies with chronic conditions, limited health funding and growing numbers of citizens living with staff. His care can support a strong political drive for patients to move away from their homes and specialist centers. Technological innovation has brought with it E-Health services that enable collaboration, information sharing and decision support based on good practices and emerging evidence-based guidelines. As a result, E-Health services is a technology-oriented and innovative process management system (Cowie et al., 2013).

1.2. Telemedicine

Telemedicine; It is the remote diagnosis and treatment of patients through telecommunication technology. Telemedicine refers to the use of technologies and telecommunications systems to deliver health care to patients who are geographically separated from providers. For example, a radiologist may read and interpret imaging results for a patient in a different county whose hospital does not have a radiologist on staff. A physician can provide an emergency care consultation via video for a non-life-threatening condition.

Telemedicine literally means “remote healing,” allowing remote diagnosis of diseases, follow-up care and treatment, and removing geographical barriers to health. Telemedicine tools allow patients to seek medical advice online and record health data and transfer it to healthcare professionals. Additionally, patient data can be automatically transmitted to healthcare professionals using bedside or portable sensors integrated into telemedical systems, and patients can be monitored remotely in real time. Since telemedicine services can be used to monitor patients remotely, improve disease management, and provide personalized patient care, chronically ill patients can greatly benefit from these services. These services allow patients to receive real-time remote feedback from their healthcare providers. Therefore, these services are of great benefit to patients living in rural and semi-rural areas who do not have direct access to primary care. However, with telemedicine services, patient treatment can be continued at home, avoiding long, costly and tiring

hospital stays and ensuring more effective use of hospital capacity. Blood pressure control can be better achieved when home blood pressure monitoring is used by healthcare professionals to remotely adjust medication dosage (Tekin, 2020).

Today, "E-Health" technology is actively used in cardiology, as well as in many departments. Einthoven discovered electrocardiogram (ECG) transmission over telephone lines in 1906. Radio broadcasts were used to connect physicians to patients on ships for medical emergencies. After decades of rigorous experimental research that laid the foundations of biomedical engineering, in 1974 Jerome R. Cox, an engineer, and Paul Hugenholtz (1984-1988), former president of the European Society of Cardiology (ESC), laid the technological foundations of cardiology. Cardiology conferences showcase current research in clinical cardiology and cardiovascular physiology, including E-Health in engineering and computer science.

Remote monitoring of chronic conditions such as heart failure has been the subject of increasing interest. A meta-analysis of a series of small-scale studies of stand-alone systems demonstrated significant clinical benefit compared with usual care provided at the time. Interventions triggered by remote monitoring or have benefited healthcare professionals, patients and their caregivers in taking on new roles. There may be little benefit to be gained from continued monitoring of well-treated patients with stable disease, but when the disease is in an advanced stage, ongoing monitoring and specific interventions may be crucial for treatment. Intermittent or “on-demand” interventions targeted to higher-risk patients to promote better care, education, self-monitoring, and adherence are likely to be more effective and a better use of resources than a “one-size-fits-all” approach.

Remote monitoring of devices such as implantable cardioverter defibrillators or cardiac resynchronization devices has been technically feasible for a significant time. Remotely evaluating patient- or device-generated alarms can lead to immediate actions that can improve outcome. Such an evaluation could potentially replace some clinic or inpatient visits, thus saving hospital costs and reducing discomfort for patients.

Clinical decision support tools that process remote monitoring reports, clinical data from hospital electronic health records, and subjective personal health data within the context of the latest guidelines can contribute to a faster and possibly more accurate clinical assessment (Cowie et al., 2013).

Recent studies show that integration of signals from various monitored variables can facilitate earlier detection of arrhythmias or technical problems with devices and better identification of patients at high risk of deterioration. Trials of devices implanted solely for the purpose of remote monitoring (such as the recent COMPASS-HF and CHAMPION studies) also suggest that there is a subgroup of patients who may benefit from remote monitoring, although much remains to be worked out in telemedicine, including standards and terminology for different patient groups.

1.3. M-Health (Mobile Health)

M-Health; GPRS (General Packet Radio Service), third, fourth and fifth generation telecommunications systems (3G, 4G and 5G), GPS (location determination), bluetooth of smartphones, patient monitoring devices, devices that act as personal digital assistants and some other wireless Devices are defined as tools that enable or facilitate the delivery of health services by using features and applications such as text messaging and voice messaging (Demirci, 2019). M-Health (Mobile Health); It is the use of a variety of technologies, including video and audio technologies, digital photography, remote patient monitoring (RPM), and storage and advancement technologies (NEJM, 2020).

Mobile Health (which can also be called M-Health or Mobile Health) is the use of mobile communication (for example, mobile phones) to receive information and benefit from health services. Mobile health applications cover a wide range from collecting health data, presenting health information to health workers, patients and citizens, monitoring health applications (such as medication reminders, pedometers, smoking cessation) simultaneously on mobile devices and directly maintaining the patient's vital signs. In particular, the use of smartphones in all areas of our lives has increased the use of mobile health applications (Kuh, 2019).

Mobile health allows patients to self-assess or control their health more actively and live more independently, thanks to remote monitoring solutions. Because mobile health apps promote healthy lifestyles, mobile health also helps healthcare professionals treat patients more efficiently. Mobile health applications are used in two different ways for both patients and healthcare professionals. On the one hand, it helps healthcare professionals to provide more effective service, on the other hand, it enables patients to receive healthcare services more comfortably (Kuh, 2019).

Providing health applications and medical services to people using mobile technology is defined as mobile health. Individuals can track their heart rate, blood pressure and daily calorie expenditure by installing mobile applications on their tablets or mobile phones that they use as their own necklaces. With the e-Pulse application, a person can enter and track their health status from anywhere with an internet connection, and access historical information at any time (Tabanlı, 2019).

Today, the majority of people in Turkey and in the world use smart phones. These and other mobile devices are used as M-Health providers to achieve better health outcomes and greater access to care.

Devices that we can define as mobile devices on M-Health;

- Medication compliance monitor,
- Bluetooth low energy thermometer,
- Independent living activity box,
- Pulseoximeter,
- Thermometer,
- Blood pressure monitor,
- Cardiovascular monitor (ECG),

- Glucometer (blood glucose meter),
- Peak flow monitors (measure respiratory values),
- Weighing (Tezcan, 2016).

Diagnostic uses of M-Health applications Portable device technology has long been used to monitor human health. One of the most common examples; are small portable glucose meters that measure the level of glucose in the blood by inserting a needle into your finger. What if we rub a drop of blood or saliva on the screen of our smartphone and it analyzes and diagnoses our disease? This analysis process is possible thanks to touch screens created by combining many technologies with years of research. In this way, the smartphone recognizes human DNA or proteins from blood or saliva. Recent research shows that this method can even be used to detect biomolecules. If biomolecules can be detected, diseases can be detected by mobile phones (Tezcan, 2016).

1.4.Personalized Health (P-Health)

Personalized health concept; It refers to a proactive approach that takes responsibility for one's own health, ensures a healthy life, strives not to be sick, keeps health records, keeps disease-related data under control 24/7 when necessary, and reports treatment protocols according to the person's genetic and personality characteristics. Tezcan, 2016).

With this definition; With the help of the Internet (which facilitates access to information) and computers, the demand for a society that is better informed and aware of its health and diseases, higher quality and faster service, technology and new trends is increasing. Indicators that determine the health system of the future are gaining importance (Tezcan, 2016).

Today, it is possible to measure physiological values such as blood pressure, blood sugar values and heart rate, and to monitor conditions such as skin cancer and otitis media with smartphone applications. Sensors designed for mood, eye pressure, lung function, movement disorders, brain waves and hundreds of medical values are used or tested in clinical measurements. Today, blood pressure, heart rhythm and rate, blood oxygen saturation, respiratory rate and body temperature can be monitored non-invasively with continuous and non-invasive methods. This not only allows many patients to measure their self-worth, but also allows them to do appropriate activities at home, at work, and while traveling, adhering to their diet, and avoiding harmful things. You can do this very easily by pressing the "Measure" or "Start" button on your mobile phone screen. Continuous measurements while sleeping or in stressful environments allow us to obtain medically valuable data. Thanks to the self-measurement model with a smartphone, people can keep their own health under control (Tezcan, 2016).

The important thing here is; It is the conversion of physiological data and image data obtained from sensors into understandable, explanatory and usable information with appropriate algorithms and supporting them with DNA data (Tezcan, 2016).

1.5.Wearable Technology

Wearables include wristbands, smartwatches, wearable mobile sensors, and other mobile center medical devices that collect a wide variety of data, from blood glucose level and exercise routines to sleep and mood. Patient data is collected passively via consumer reporting or sensors in applications that communicate with devices via application programming interfaces; this data is then shared through data collectors that aggregate data from multiple health applications (Grundy et al. 2017).
According to a recent consumer survey, a significant percentage of US adults agree to use technology that tracks health statistics. Due to mobile integration platforms such as Google Fit and Apple Health Kit, it is predicted that there will be a significant increase in the number of users of wearable technologies in health in the next few years. The increasing trend in device use to monitor health-related data also indicates a corresponding increase in patient data available for health management. Major healthcare systems are likely to move towards wider uses of wearable technology in the next few years, and they are expected to include wearable devices by monitoring heart rate, blood pressure and other information, potentially as part of their preventive care strategies. Currently, there are more than 400 electronic health record-compliant wearable devices on the market and this number is expected to increase exponentially in the coming years (Al-Siddiq W, 2019; Joszt, 2018; Statista, 2018; Pettey C, 2018)

The complexity of wearable devices increases as patient data from wearable devices is processed and stored. Obtaining patient consent is also important, as patients are likely to be under constant surveillance. Misuse of personal health information by third parties can lead to discrimination, changes in insurance coverage, and even identity theft. In conclusion; Consent statements should provide sufficient detail about what personal information is collected and how often, identify third parties who have access to patient data, and ensure informed consent is obtained from the patient. It is considered that additional policies and standards are necessary for the future of wearable health technology and the integration of patient data into electronic health records to ensure the confidentiality and privacy of patients (Banerjee et al., 2018; Terry, 2016).
From fitness bands to ingestible sensors, numerous wearable technologies expand the possibilities of medicine. The development and development capacity of wearable technologies has reached a level that facilitates the transformation of health and attracts the attention of the health insurance industry. Wearable activity trackers are leading the active market. Some of these devices, which can measure from step to step, can even send the measured data to smart phones. The sales success of these devices is based on the fact that the target audience is young, enthusiastic about sports and has a high purchasing tendency (Tezcan, 2016).

Wearable devices can perform more operations than many technological devices. It can easily perform many operations that smartphones and computers cannot. Jewelry such as watches, bracelets, glasses, lenses, e-textiles, smart fabrics, headbands, rings and hearing aids are now wearable devices. By means of these devices, it is possible to monitor, record and monitor the biological feedback and mental states of the person.

Figure 2. Wearable Technology Samples
Source: Wearable Technology Samples, 2020.

Wearable technologies are much more than pedometers. Scientists are pushing the boundaries of this technology with robotic homes for paraplegic patients and very thin, embedded sensors that monitor functions by connecting them to organs.

Health insurance companies can reap great benefits by adding wearable technology to their policies. With the use of these technologies;

- You will have healthier customers.
- You can use better risk management and maintenance models.
- You can work more closely with healthcare professionals.
- You can benefit from more specific, personalized diagnosis and treatments.
- You can expand customer portfolios, reduce the risk of risk groups, reduce costs and optimize sales (Tezcan, 2016).

Wearable technologies equipped with sensors, connection to the internet via the cloud, or both provide health and fitness tracking to individuals and healthcare professionals.Wearable technologies are all electronic devices that can be worn on the body or inserted into clothing or accessories. Wearable devices can do many things that computers and smartphones can do.

Wearable technologies enable better nutrition, movement control, better access to medical information, patient and individual participation in clinical decision-making, and more accurate diagnosis of disease or health problem. Thanks to these technologies, users have the ability to control and manage their own health. Health institutions have the opportunity to reduce their costs,

improve their services and increase their efficiency thanks to devices that can monitor patients remotely (Demirci, 2019).

Long-term monitoring of physiological data thanks to wearable technologies enables the early diagnosis of diseases such as cardiovascular disease, high blood pressure, diabetes and obesity, as well as the development of emergency treatments. Databases created with data obtained from portable devices can store epidemiological information that will contribute to the development of public health.

Additionally, healthcare costs can be reduced and outbreaks can be detected in advance. Wearable technologies, which have a wide range of applications, will be widely used in medicine and will enable diagnosis and treatment outside the clinic. These devices, which can also be used in medical education, can reduce abuse rates by providing medical students with a more realistic learning opportunity (Demirci, 2019).

Devices that can be connected to the human body in various ways and are mostly used as various accessories are summarized under the title of wearable technology. When talking about portable technologies in the literature, portable computers are mentioned. This is because these technologies act as a bridge between computers and humans and enable them to live together. Examples of wearable technologies are smart watches, bracelets and glasses, or sensor chains and rings. As technology moves rapidly, innovations increase day by day and a new example is added every day.

Individual measurements are an important factor in regulating quality of life. Wearable technologies are also used for these measurements. The person will observe his negative behavior and try to correct it according to the measurements he makes. People have great difficulty evaluating the health data they collect. However, smart wearable technologies collect and record this data, saving people from this effort. Wearable technologies improve our healthy living behavior. In this way, the user can obtain personal health information within the scope of numerical values by making all kinds of data recording and calculations without having to make any extra effort (Kuh, 2019).

1.6. 3D Technologies

3D printers are extended versions of the two-dimensional printers used today. 3D printers are used in many industries, including the healthcare, automotive, aerospace and defense industries. Especially in the health sector, the use of 3D printers is increasing. 3D models of digital images captured with medical imaging equipment such as Computed Tomography and Magnetic Resonance Imaging (MRI) are developed and converted into physical materials (Demirci, 2019).

3D printing costs are gradually decreasing. The issue of personalized printing and transplantation of organs is still at the experimental level today. Despite this, the transplantation of organs printed for personal preferences has created a great wave of excitement (Hernandez Korner et al., 2020; Zadpoor and Malda, 2017).

The practice of a technology such as 3D printing contains numerous and important opportunities. According to this:

• Pre-operational planning: 3D printing is used before the operation to increase the quality of the pre-operational planning and thus make the operations deemed impossible to be implemented (Perica and Sun, 2017).

• 3D printing of medical devices: The main purpose of printing disposable devices is basically to respond to the growing need for personalized care that recognizes the uniqueness of each patient (Pravin and Sudhir, 2018).

• Orthopedic implants: The evolution of 3D printing and additive manufacturing has played an important role in orthopedic surgery. The fusion of the electron beam with a titanium alloy makes it possible to manufacture implants that meet the stiffness requirements for effective bone fusion (Lal and Patralekh, 2018).

In healthcare, 3D printers are used to make implants and prosthetics, medical models, and develop medical devices. Many organs and tissues are produced thanks to 3D printers, which are widely used in health promotion and health services. Some of these organs and tissues are:

▪ Ear design for people with hearing problems,

▪ Copying bones with 3D scanners,

▪ Manufacturing of bridges, fillings, prostheses and crowns for dentists,

▪ Demonstration of the 3D shape of the fetus for pregnant women,

▪ Using patients to create an organ that is right for them, rather than waiting for an organ transplant,

▪ Development of artificial limbs for those who have lost their limbs,

▪ Development of individual drugs,

▪ It is used to develop a new jaw in people with a broken jaw (Demirci, 2019).

1.7. Electronic Health Records (EHR)

Although electronic health records date back to the 1960s, their widespread adoption begins with the enactment of the Health Information Technology Act for Economic and Clinical Health in 2009. The number of physicians using electronic health records increased from 18% to 57% between 2001 and 2011. Policies such as prioritizing the quality, care, coordination and security of personal health information have encouraged the use of electronic health records. In a study, as of 2015, approximately 89% of physicians have adopted an electronic health record system. Among

all electronic health record vendors, Epic, Cerner, and Meditech are the most widely used (Cohen, 2016; Tanner et al., 2015; Vaidya A, 2017).

Electronic Health Record (ESC) was introduced gradually in day-to-day clinical care, initially following a parallel trajectory with telemedicine. The biggest obstacle to the adoption of this system is the lack of interoperability which causes the EHR systems to be disconnected. However, EHR is increasingly used in daily medical practice. In particular, cardiologists rely on this system for programming and remote monitoring of CIEDs, functionality integrated into patients' electronic health records in many large hospitals. In the future, as personal health records and health plans gain popularity, activity and lifestyle data will undoubtedly add to the EHR. Moreover, the adoption rate of IHC systems is increasing, due to financial incentives and possibly a change in culture. However, discussions on the functionality, standards, and certification criteria of EHR systems have come to the fore, as physicians are unsure of what to expect from an EHR system.

Recently, a flexible data structure called FHIR (Fast Healthcare Interoperability Resources) has been developed to represent clinical data in a consistent, hierarchical and extensible format. Although this developed structure has simplified data exchange between sites, the format does not provide semantic consistency and the need for additional techniques to deal with incompatible data continues (Mandel et al., 2016).

The use of deep learning in data obtained from electronic health records has increased after the processing of electronic health records and the development of deep learning methods. In one study on the topic, researchers used automatic encoders to predict a specific set of diagnoses, and in another study, they extended this approach by modeling the temporal sequence of events that occurred in a patient's record. After these studies, it was evaluated that the accuracy of the scenarios depending on the order of events could be increased with recurrent neural networks. In general, previous studies have focused on a subset of the features found in electronic health records rather than all the data contained in an electronic health record system containing large amounts of structured and semi-structured data. Due to the availability of Medical Information Mart for Intensive Care (MIMIC) data, most previous studies focused on ICU patients from a single centre. Each intensive care unit patient has significantly more data than an ordinary inpatient. However, the number of hospitalizations outside of the intensive care unit is much higher than that of the intensive care unit. Recently, researchers have also explored how interpretation mechanisms for deep learning models can be applied to clinical predictions (Aczon et al., 2017; Fast Facts on U.S. Hospitals, 2018; Johnson et al., 2016; Shickel et al., 2018; Suresh et al., 2017).

In the light of the data obtained in recent studies:

• A generic data processing pipeline has been introduced that can input data from raw electronic health records and produce FHIR outputs without manual feature harmonization; this system provides an easy integration to a new hospital.

• Based on data from two academic hospitals with a general patient population not limited to the ICU patient, the effectiveness of deep learning models in a wide variety of predictive problems and in a variety of settings such as multiple prediction timing has been demonstrated.

Features of EHR;

• To provide accurate and up-to-date information about patient health,

• Providing quick access to the patient's medical report for a coordinated health care,

• Secure sharing of medical information between patients and physicians,

• Reducing costs thanks to reduced paperwork,

• Increasing the security and confidentiality of patient data,

• It helps to increase treatment efficiency.

Key Information Contained by the EHR:

• Laboratory results: The EHR contains reports of all the patient's laboratory tests. With the EHR, the patient and the medical clinic do not need to keep these documents on file separately.

• Images from radiology: EHR system, g from radiology

2. DISCUSSION: HEALTH MANAGEMENT AND HEALTH 4.0

When we look at the health policies of countries in the world, they primarily provide important services in the field of chronic diseases in the provision of e-health services to their citizens with these diseases. The health care process is a very costly process. In this context, the use of Industry 4.0 in healthcare services has reduced these costs.

Thanks to these services, cost reductions, early diagnosis and treatment of diseases have been achieved, hospitalizations and admissions have been reduced, contributed to the satisfaction of patients and healthcare personnel, provided ease of use, saved time, and also prevented unforeseen illnesses, etc. helped reduce their condition.

With the use of industry 4.0 in healthcare services, innovative applications have contributed to increasing the quality of patient care, reducing costs, increasing evidence-based medical practices and scientific and technological knowledge in medicine.

The continuous increase in the costs of diagnosis and treatment in health services has led to the emergence of innovation practices of health care institutions and organizations to develop effective, efficient, economical and patient-centered services. In order to adapt to the information and

technological developments in the field of healthcare in the world and to take a strong place in the competitive environment, it has become necessary for healthcare personnel and administrators in healthcare services to constantly renew themselves and their healthcare policies and make innovation a part of their lives.

Since innovation practices need to be constantly developed and increased, an innovation culture needs to be created. In order for this culture of innovation to become permanent in healthcare personnel and administrators, training and practices will contribute positively to creative thinking. In this regard, it would be beneficial to make arrangements in the training programs of health academics to ensure the establishment of a culture of innovation and subsequently contribute to innovative thinking.

Today, artificial intelligence and open innovation applications guide all branches of industry in which countries grow economically internally and externally and constantly develop with innovative technologies. These technological innovations not only open new markets to businesses in the global economy, but also offer them the opportunity for sustainable competition. These innovations play an effective role in facilitating businesses in the process from design to production and promotion of a product. Because, with artificial intelligence and open innovation applications, processes are becoming automated. Automating processes for businesses provides the advantage of reducing costs, including management, design, production and promotion processes, and offers the experience of providing more innovative services and products to customers. Thus, businesses with an innovative transformation; They offer innovative solutions by eliminating many problems with new technologies such as the internet of things, virtual reality, augmented reality, robots, cyber security systems, learning algorithms, smart sensors and cloud computing.

Artificial intelligence and open innovation applications for businesses; It also offers convenience and advantages in operational, storage, logistics, management and procurement areas. While technology is now becoming an object, businesses benefit from artificial intelligence and open innovation practices by paying attention to the methods of collecting data and using this data; It has to have the right skills, the right culture and the right technology. For this reason, it is very important for businesses to focus on creating a data-focused culture based on open innovation in terms of innovations expected in the future.

E-Health applications are widely used in many developed countries today. E-Health applications will have significant and significant positive effects in the areas of reducing the stress of family caregivers, allowing family members to spare more time for other work, reducing the stress of family caregivers and improving family functioning.

The use of communication tools facilitates the work of health care providers due to geographical location and lack of resources. The use of telecommunication in care has increased, especially with the low cost and remote monitoring method.

Today, projects such as family medicine practice and information system, prevention of data loss, hospital appointment systems, e-prescription, electronic referral system, electronic ID card, home

health services established within hospitals are implemented, and important steps are being taken regarding tele-health practice. Thus, the obligation of patients to be dependent on a single hospital in order to prevent data loss is eliminated. In our country, some private institutions have started tele-health and tele-care practices that include remote monitoring and control of blood sugar, blood pressure, weight and falling of individuals with chronic diseases such as hypertension, heart failure and diabetes.

3. CONCLUSION AND RECOMMENDATIONS

In order for Industry 4.0 and Innovative Approaches in Health Services to be carried to the next stages and become systematic, it is necessary to create appropriate medical terminology systems, and at the same time, it is necessary to train health personnel who are capable of using all this technology. These trainings should also be given to patients and their relatives who will use these technologies on the subject.

With these applications, health personnel should learn the important advantages as well as the disadvantages of remote patient care, diagnosis and treatment procedures and use them accordingly. Patients and their relatives should also explain that they are within a phone call distance.

Health personnel who have been working in the profession for a long time should realize that this is not only applications for doctors and nurses, but also a multidisciplinary scope such as pharmacists, psychologists, medical informatics, physiotherapists, dietitians, information security. In this multidisciplinary field, accessing and sharing information, as well as the use of e-health services by all healthcare professionals who provide health services, and the access and development of these technologies, including academic publications, especially R&D activities. It will be useful for dissemination. Increasing the quality of health services will provide significant benefits in terms of efficiency, effectiveness and efficiency. In terms of literature, it will also contribute to the refreshment and elimination of missing information.

It is of great importance that the managers of the institutions and organizations providing health services and the administrators who shape the health policy lead instead of resistance in the development and dissemination of innovative studies in the field of health in our country. In this, it is imperative that innovative applications are well understood by these people. Providing sufficient and timely resources for innovative projects by these people and trademarks, patents, etc. for the products created after the projects. They should also take part in intermediary activities in matters. Since the reward system for the personnel involved in the development and use of innovative approaches in health services will increase the morale and motivation of the personnel, an appropriate reward mechanism should be developed.

These innovations and innovative approaches in health services not only use the resources of the society effectively, efficiently, effectively and correctly, but also improve the lives of individuals, benefit health care providers and the relatives of patients. Therefore, innovative approaches have an important role in the health system. Along with innovation in health, the added value that our

country will gain in the international market and the benefit it will provide to our country's economy are very important. In addition, it is extremely important that it will not contribute to our country's becoming a brand in the field of health. For this reason, more importance should be given to innovation in health, and it is important to provide the necessary conveniences in legal, administrative, financial and branding issues to people, institutions and organizations working on this issue, both in terms of quality health service delivery and its contribution to the country's economy.

Hospitals, which are one of the most basic elements of the health system, are distinguished from other service sectors with their unique structure. It is only possible with innovative studies that hospitals can continue to function and compete, and meet the expectations and needs of both the people in the service they provide and the patients who receive this service.

Providing a suitable environment for innovative approaches in the field of health, supporting the personnel, rewarding in order to encourage contribution to the service, strengthening cooperation and communication, ensuring that they can express their ideas freely, ensuring equality of opportunity without discrimination of profession and person in these approaches, and providing the support of the managers in expressing their ideas. will help increase its potential. In the development of these innovative approaches, public and private health institutions and organizations and personnel can be supported in terms of common space use, material and equipment cooperation, joint use of personnel, training and financial support.

Regulations of the public that create bureaucratic difficulties for innovation need to change. Information security and cyber security should be trained and necessary precautions should be taken.

In our country, IT Specialization is a developing field. Medical Informatics graduate programs should be expanded and the number of personnel trained in this multidisciplinary field should be increased.

Activities within the scope of R&D and project support given by KOSGEB, TUBITAK and TUSEB should be followed. Technology fairs where information sharing and different products and models are intensely experienced.

Providing a competitive advantage on a global scale ensures the growth and development of the country in question in terms of social, cultural, economic, in short, social aspects. In order for a country to be among the countries with high competitiveness, it must follow innovation developments at the global level and not fall behind the countries implementing Industry 4.0.

The innovation application in the appointment process (MHRS) is not used by approximately one in every four people applying to hospitals. In order to encourage dissemination on this issue, information or training activities can be carried out in the name of awareness and consciousness raising.

In the field of production and supply, studies can be carried out by developing new techniques and methods on control and production business mechanisms by developing systems integrated with artificial intelligence into the lean production techniques of organizations by using open innovation practices.

It should be considered that an artificial intelligence system integrated with lean production will make a significant difference to the economy in global competition. 3D printers, which have been in use for more than thirty years, have taken their current form by using many technologies, sizes and materials. For example, although it offers cheaper and more useful opportunities in many sectors such as education, automotive, health, jewelry, moulds, white goods and so on, its use has not yet become widespread. However, it provides both speed, technical and cost advantages. At this point, production techniques should be expanded with the support of artificial intelligence and open innovation in order to multiply 3D printers with domestic production and enter every workplace and every home.

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