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The Historical Determinations of Creating Health Records – A New Approach In Terms Of The Ongoing Covid-19 Pandemic

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Summary

The history of health records (later also called medical records), including ones regarding individual patients, is thousands of years old. It finds it roots in the first ancient civilisations. Up until the 19th century the records' purpose was mainly an educational one. In the 19th and 20th century they started becoming significant in other roles as well, including those not strictly limited to medicine. In particular, to account for medical procedures, insurance proceeds or legal action. Currently we are living in a revolutionary era when it comes to health records, in which their character has changed from a "paper-based" to an electronic one. This paper presents the development of health records from the ancient to modern times, mainly in Europe and North America. Other cultures and civilisations, including China and India, are not discussed. An analysis of available sources was conducted, inter alia digital versions of manuscripts up to hundreds of years old. The analysis was based on PubMed and Google Scholar (several key words, all the available sources). Sources published in non-international languages (e.g. Dutch) were also investigated. Overall, approximately 600 articles were analysed, 158 of which were used and cited in this paper.

The conclusions drawn from the analysis are as follows:

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1. Health records, priorly used mostly for educational purposes, for about 100 years now have acquired a fully formal status.
2. We are currently facing the most revolutionary changes regarding the transformation of paper-based records into electronic ones.
3. The consequences of this process include systematic applications of solutions within the area of e-health, which allows us to make medical services more flexible, improve the health of individual patients and entire populations and potentially limit expenditure.
4. In the light of the ongoing COVID-19 pandemic, introducing electronic health records could be beneficial in terms of limiting the potential sources of contamination (physical copies of health records), saving time and resources, and improving the network of communication between medical centres

Key words

Health record, electronic health record, e-health record, the history of medicine, the economy of the healthcare system

Ancient times and Middle Ages

Human history shows that one of the most prominent features of *homo sapiens* is intentionally leaving the traces of one's actions, documenting them, and setting up various sorts of records. One of the earliest proofs of this hypothesis is the presence of cave paintings, created during the early Magdalenian (17 000-15 000 years ago) in the Lascaux cave complex in Nouvelle-Aquitaine region in southwestern France. One of the paintings shows an injury of a man attacked by an animal.

It is arguably the first available health record in the world shown in the form of a pictogram, illustrating a probable multi-organ injury. Along with the development of the first civilisations, writing became a tool of communication, allowing people to record their knowledge. Proto-writing is believed to have appeared for the first time in the Vinča culture (5500-4000 years ago), while a more advanced, logographic system in a form of pictograms was developed by the prehistoric Egyptians around 4000 BC, as well as the Elamites and the Sumerians. The first records of a systematic and informed character are believed to originate in Sumer (cuneiform writing) and Egypt (hieroglyphics) around 3000 BC. [1,2,3,4,5,6,7,8,9,10,11].

Previous multi-specialist research conducted mainly by historians, archeologists and physicians did not allow to conclude a date when health records first appeared in the ancient world, and what role they might have had. However, it has explained the significance of recording the history of the present illness to the development of medical knowledge over time. [12,13,14,15,16,17,18,19,20].

Medical records similar in structure to modern ones were first developed for educational purposes. The reviewed sources mention ancient Egyptian medical papyruses. In 1862 an American Egyptologist bought a manuscript written between 1600-1700 BC, which

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was named after him – "Edwin Smith papyrus". It is the oldest known medical script about various injuries. It describes the methods of examination and determination of a diagnosis and ends with a treatment plan. Another example, "Ebels papyrus", bought in the 19th century by a German of the same name, was an extensive source of knowledge about the treatments, surgical procedures and healing herbs known in ancient Egypt. Nowadays, it is considered lost. [12,21,22,23,24,25,26].

Modern medicine has been influenced much more greatly by Hippocrates of Kos (460-370 BC). The treatment plans, ethical rules, and laws included in his school of thought are described in a book fundamental for the modern medicine – "Corpus Hippocraticum". It consists of around seventy medical scripts written before the first half of the 4th century BC, compiled about 100 years after the death of Hippocrates. Their structure resembles those of modern health records, they also include physicians' recommendations, descriptions of medical procedures, and receipts. Elements of medical law are included, but they are mainly brought up for academic purposes. From the point of view of orthopedics and traumatology of motor organs, "Corpus Hippocraticum" mentions neuro-orthopedics with recommendations regarding the treatment of scoliosis and often complex holistic clinical observations about prosthetics, podology, and bone fracture treatment. It is impossible to trace the original sources of knowledge encapsulated in "Corpus Hippocraticum". However, we can predict to a high degree of probability that they are much older than the script itself and like the majority of the original knowledge sources of the Hellenic world were destroyed during one of the fires of the Library of Alexandra; the biggest library in the ancient world, established by Ptolemy I Soter. Modern Europe learned about the advancements from the "Corpus Hippocraticum" in 1525, when it was translated for the first time and printed in Venice. From a 21st century perspective, a full re-enactment of the Hellenic health records is impossible, due to the fact that only some of the medical scripts included in "Corpus Hippocraticum" met the requirements of being called proper "records". [27,28,29,30,31,32,33,34,35,36,37].

The rules and knowledge passed on by Hippocrates were introduced to the Roman world by Claudius Galenus (130-200 AD). In the centuries that followed, he became the main representative of Roman medical culture, known as Galen. Like Hippocrates, he created educational health records. Roman law, which was later used as a foundation for the modern European legal system, banned performing post-mortem examinations from 150 BC. Galen adjusted to this law, which became apparent in his works. He was an accomplished physician; whose influence continued into the 17th century. Ironically however, it slowed down the medical progress in Europe, where adapting his teachings ruled out the possibility of performing post-mortem examinations. In that way the Roman law affected the world of medicine, including medical procedures and how they were being registered. [38,39,40,41,42].

Another interesting historical period from the point of view of medicine is the Islamic civilisation in the early Middle Ages where manuscripts and documents played a crucial role. Two influential doctors originated from that culture: Abū Bakr Muhammad ibn Zakariyyā al-Rāzī, also known as Rhazes (865-925 AD) and Abū Ali Husain ebn Abdallah Ebn-e Sina, also known as Ibn Sina or Avicenna (980-1037 AD). The medical knowledge passed on by Rhazes is a compilation and a synthesis of Arabic civilisation's achievements in the early Middle Ages. It

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consisted of scientific advancements of ancient Greece and the entire Hellenic world, as well as ancient Indian civilisations taking their roots in the very first human civilisations of Harappa and Mohenjo-Daro, where medicine was practiced on a relatively high level. The most famous work by Rhazes is a 9-volume "Al-Kitab al-hawi" (transl. "*The Virtuous Life*, *Continens Liber"). It* contained clues and elements for creating what we nowadays define as health records. The fundamental work of Rhazes introduced one of the first concepts of cast and can be considered a source of information on creating educational health records. [43,44,45,46,47,48].

Another accomplished physician in the early Islamic civilisation is the aforementioned Ibn Sina. He was an erudite, fluent in reading the Qur'an at the age of 10 and a polymath like Rhazes. Ibn Sina studied law and natural sciences. It helped him develop an analytical approach towards his medical texts, encapsulated in over 400 books. The most fundamental of which, that is "Kanun fi't-tibb" (transl. "*The Canon of Medicine"*), in Europe known as "*Canon medicinae"*). The medical knowledge included was highly organised. The entire "*Canon …"* consisted of five books, each of which was divided into parts, and then chapters. They described a variety of cases based on the previous educational health records. The construction of the encyclopaedia, that became a fundamental textbook in medical schools up until the end of the 18th century, strongly resembled a structure of common law. It allowed to treat the Ibn Sina's work as a source of references for the medical texts in the centuries to come [47,49,50,51,52].

Moses ben Maimon (1138-1204) was a rabbi, a philosopher, and a physician. The complicated political and religious situation in Spain forced him to leave Europe and settle in North Africa. He became a doctor to vizier Al-Fadhil, a regent of Egypt. In his medical practice, he noticed a connection between "psyche" and "soma" in patients, which was heavily influenced by his philosophical and religious background. Moses ben Maimon's motto was "treat the ill, not the illness". His largest and most famous work is "Pirkei Mosche", which included clinical descriptions of many diseases. He encouraged preventive healthcare and was convinced that the key to a healthy life lies in one's relationship with nature, one's surroundings and moral values. Maimon gave rise to an idealistic approach of "doctor-patient" interaction we expect today. His scripts can be treated as educational health records [53,54,55].

Medicine and health records may simply be connected to a term "hospital". However, in medieval Europe, unlike nowadays, hospitals were treated as asylums for the poor and ill. They were managed mainly by convents, which was an effect of the Christian moral imperative to do good and show mercy to those in need. There were exceptions to the rule, and some of the institutions conducted research and stood on the edge of medical progress, which was shown in the educational health records. One of the examples was famous in medieval Europe, but often forgotten today Schola Medica Salernitana. The progress was also made at the frontiers of cultures and civilisations. [56,57,58,59,60,61,62].

Civilisations were functioning independently from each other, so their health records differed accordingly. Regardless of the place, their primary purpose was determined by the administrative organs, almost always connected to the Church. The lists of patients admitted and released from the hospitals have been kept in many such institutions and are nowadays considered one of the first examples of medical data archiving in Europe. Medieval health records can be considered as more autonomous than ancient ones, and a habit of documenting

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the medical procedures or observations became a constant element in medical practice [17,63].

Health records throughout history have had a narrative character, which changed depending on the period in which they were written. It can be said with certainty that those from ancient times intellectually towered above their medieval counterparts [4].

Modern times

Changes came with the renaissance and the work of Leonardo da Vinci (1452-1519). Research conducted by just one person turned out to be a steppingstone in many sciences, including medicine. The development of numerous branches of medicine would have been difficult to imagine without da Vinci's anatomical sketches. Sketching became a universal educational health record, used over the next centuries up until the end of the 20th century especially by orthopaedics. Currently, in the second decade of the 21st century, handmade sketches do not exist as a form of health records. They do not meet standing requirements, especially in case of electronic health records [64,65,66,67].

Another figure that brought changes to operating algorithms in medicine was Andreas Vesalius (1514-1564). In 1534 he published "*De humani corporis fabrica*" (transl. "*On the fabric of the human body"*), which revolutionised the field. Health records began to include elements of post-mortem sketches. Those dedicated for Vesalius' book were made by Jan van Calcar, a pupil of Titian. The advertising company for "*De humani corporis fabrica*" was managed by Rembrandt Harmenszoon van Rijn (1606-1669) himself. In one of the most famous "medical paintings", "*The Anatomy Lesson of Dr. Nicolaes Tulp",* Vesalius' book can be seen in the left right corner [42,68,69,70,71,72,73].

Nowadays, it is difficult to find and point out the actual connections between scientists and artists from the renaissance. The intellectual elite of that time consisted of few people. However, universities kept in contact with each other and collaborated. The entire process of promoting the anatomical knowledge included planning the research, conducting post-mortem examinations, proving almost 200 inconsistences with the Galen publications which at the time were considered exemplary, creating the sketches and write-ups, publishing the results, obtaining feedback, and advertising the results. It remains unclear whether all these actions were thoroughly planned for, or came to be due to serendipity, but Galen's view of medicine lost its relevance [73].

The 17th century brought the rapid development of the natural sciences in Europe, as a consequence of curiosity awakened by the renaissance. Post-mortem examinations were being conducted on an unheard of before scale, which provided material for a gigantic amount of health records. The phenomenon proved favorable to the development of science as a whole [35,74].

While discussing the health records created during that time, it is impossible not to mention Philip Verheyen (1648-1710), who had his left leg amputated during the second year of his studies. Verheyen was deeply religious, and therefore wanted his body to be buried

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intact, awaiting resurrection, so he kept his amputated limb in a substance preventing the decay. The personal tragedy did not stop him from contributing to medicine, as he described his phantom pain in such a professional and skilled manner, that it still serves as an example today. As the concept of phantom pain was unknown in the 17th century, the scientific curiosity could have been the reason Verheyen began studying anatomy. His notes compiled between year 1700 and 1710 were published as "*Letters to my amputated leg*" [75,76].

In 1693 Verheyen started performing post-mortem examinations on his amputated leg, which resulted in a discovery of Achilles tendon. Based on his exemplary notes, he wrote and published a book called "*Corporis Humani Anatomia*". In the first decade of the 18th century it was considered the best medical textbook by the majority of European universities [77,78].

Towards the end of his life, the notes were becoming increasingly less readable, as many researchers have pointed out. It emphasizes the importance of health records' clarity if they are to be used later [79].

The amount of health records in a form of sketches and descriptions made up until the beginning of the 18th century is difficult to estimate. War-torn Europe (mainly by the Thirty Years' War and the Great Northern War) saw many of her important texts lost. At least half of all parish registers, considered as one of the most important documents at that time, is believed to have been destroyed. Probably not many doctors in Western Europe in the mid-18th century kept health records, and only a percentage of them have actually been researched [17,80,81].

Meanwhile, an accomplished American physician Benjamin Rush (1745-1813) educated in Edinburgh, Scotland kept very detailed health records of his patients in a form of a book. Nowadays his work is considered to be an archetype for medical history [4].

At the same time, the character of the hospital began to change from the end of the 18th century. It was no longer considered an asylum for poor and was now seen as a proper medical centre. Changes were also seen in everyday doctor-patient relationships. Some researchers consider this time to be the start of the modern health records' system, as they found orderly examples of health records written in national languages, such as German, and not in Latin [17,82].

Other historians point out another significant event to be a steppingstone in the process of officializing health records – at the beginning of the 18th century medical-surgical military courses were moved to universities in Berlin and Paris. They were later transformed into medical "schools", which developed their own procedures and methodologies, including those regarding health records [83,84,85,86].

In 1724 Berlin, formerly the capital of Prussia, a garrison hospital was rearranged into a *collegium medico-chirurgicum,* later called Charité by Frederick William I of Prussia. The first director of the institution was Johann Theodor Eller (1689-1760), the Royal Doctor. One of the routines in the collegium was everyday inspection of patients conducted by junior surgeons - which involved writing up the patient's condition and the history of treatment in a form of a journal. Johann T. Eller considered it the best form of education, that enabled the doctors to gain new skills and brought benefits to patients. He introduced a hierarchical system where

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health records were a form of communication between experienced physicians and their pupils. All these modern ideas fell into the concept of enlightened absolutism, the Prussian version of Enlightenment. The strong centralised political power of the monarch supported by the developing bureaucracy became an example to follow in institutions such as Charité. It also influenced the way of creating health records [83,87,88,89,90].

In Paris, Hôtel-Dieu hospital became an important centre for development of medicine and medical education thanks to Pierre Foubert (1696-1766) and Pierre-Joseph Desault (1744-1795). Everyday check-ups on patients were obligatory and provided data needed for research. In 1791 Pierre-Joseph Desault established "Journal de chirurgerie", which included the most interesting cases he came across, with his personal comments. In that way for the first time in modern Europe the concept of in-depth health records became not only a set of tips for treating patients, but also a base for scientific research.

In the 18th century Europe a uniform way of registering patients was still not a case, but the advancements were being made, with Paris and Berlin as pioneers.

The last two centuries

The United States started developing a permanent patients' case records system independently from Europe. According to American sources, the steppingstone in the process was introducing in 1793 The Book of Admissions and The Book of Discharges in a New York hospital opened in 1791 [17,94,96].

In 1793 the Governor's Council approved of the first hospital rules, introducing a medical register among other things. It is also known that Dr David Hosack and Dr Alexander Hamilton suggested the Governor's Council at the beginning of the 19th century that home doctors should have a register of all medical cases. The aim was to preserve the gained knowledge in a written form, which could later be used by medical students. Their proposition was implemented [96,97].

Unfortunately, inscriptions were initially few and far between, and many of them had a retrospective character, which allows to guess that they were not written immediately after treating patients. Some inscriptions appeared to be personal notes rather and suggested that a definition of moral behavior towards patients was often misunderstood [96,98].

However, the bureaucracy was not as developed, which to some extent allowed the doctors to write in their own individual style. The length of the inscriptions varied, depending on the complexity of the medical problem and the physician's approach towards it [99]. Their structure also varied depending on the doctor's creativity or mood. One of the cited inscriptions reads as follows: "…Now it is a partial paralysis of both touch and movement, of both upper and lower limbs, he cannot walk (…) without a stick. (…) What troubles him now are overgrown testicles (…). He said he had night sweat (…). He does not have rheumatism or syphilis, and says he has no appetite; but he was practicing masturbation. He lost a lot of energy, is pale, and his left side is worse; his mind and eyesight are alright; and he is a hypochondriac…". Despite the efforts of the Governor's Council, which hired so called conservators to supervise the registers,

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inscriptions made were far from acceptable when it comes to modern standards. The structure of textbooks was not much more professional, as even mocking patients was considered normal [96].

From today's standpoint, health records created back in the 19th century often reflected the cultural stereotypes, personal medical theories, and philosophies of their authors. It quickly became apparent that inscriptions had to be held to a certain standard [96,99].

The hospitals' boards initially established rules of creating health records accordingly to what nowadays we would call a vision of organisation [100, 101].

However, that did not prove to be enough. Eugenia L. Siegler, who analysed the transformation of health records in the 19th century, found an "exemplary" note, written by hand: "vs stbl, o ~ comp.; no! as follows. - 02 sats ok; xam un -! 'd look 11/12; fam. visit.; no nursing problems; labs „no incr. aldolase, CK's; note: this enctr., took 65 'i inv. hi. Komp.". The usefulness of the note is none for the bystander not familiar with the abbreviations. This showed the need for creating a database with abbreviations appropriate for medical inscriptions [96].

Because the Governor's Council required annual reports, staff's duties regarding health records were clearly defined. Hospital admissions, discharges, the results of the treatments and expenditures. Putting together admissions and discharges was necessary to document the medical achievements, but also to justify the expenditures. That is why in 1830 all patients were supposed to be registered, and their numbers were obligatorily connected to the prospects of the doctors' promotions [96].

At the same time changes concerning health records were also happening in Europe. Due to the well-kept medical records from Berlin and Paris, many observations in the bibliography are made based on them. Historiographical analysis shows that some health records written in the 19th century resembled the ones of today [17,95].

Up until the beginning of the 19th century, diagnostics in modern Europe and United States were based predominantly on anamnesis. They focused on a well-conducted interview with a patient, while the actual physical examination was not as crucial. It was changed by the French view on the clinical practice. One of its representatives was Dominique-Jean Larrey (1766-1842), a physician to Emperor Napoleon I, a surgeon in Val-de-Grâce hospital in Paris and one of the pioneers of modern combat surgery. He treated the actual examination of the patient as a priority. Meanwhile, the German view of the laboratory medicine introduced a need for recording and analysing more pure data, which is believed to have influenced the way health records have been conducted since then [74, 102].

Another important historical modification in the health records' field was introducing the actual registries of patients, which began in Paris and Berlin. The implementation became easier after diagnostics started including statistical analysis, which served as a basis for epidemiology, clinical research, and evidence-based medicine (EBM) [4, 17, 102, 103, 104].

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According to Barbara L. Craig, this historical period was crucial for the introduction of the modern health record system, which was analysed based on four hospitals in the United Kingdom (London) and Canada (Ontario) [105, 106].

The changes became noticeable as late as the mid-19th century when doctors started registering data of all their patients. Universal templates of health records were introduced to avoid confusion during case conferences [96, 100, 102].

If the medical records were written as literary texts, losing some fragments during archiving could be easily detected. However, while dealing with the schematised documentation these gaps often went under the radar, as they did not disrupt the general structure of the report. The problem, pointed out by Brigitta Bernet, might have been a reason to keep the British medical records in a form of literary texts. The change came with digitalisation [17].

The growing specialisation in healthcare which began emerging in the second half of the 19th century affected the structures of hospitals and the form of medical records. The sheer amount of the records was also becoming increasingly larger, they were also copied and cultivated in libraries. The New York hospital implemented this procedure for research and educational purposes in 1908 [94,96,107].

The classic examples of a full history of the present illness (HPI) in the Anglosphere includes a letter from a doctor, epicrisis and casuistry. According to Sophie Ledebur they can be divided into observations of the first and the second category [108].

At the turn of the 20th century “the lose segregated files” were replaced by reports, which later became archetypes for health records in the Anglosphere. Every author of the report had to put his/her name down after the previous person in a chronological order [109].

According to Barbara L. Craig around the year 1900 there was a change in administration techniques which involved binding the documents and collecting them into folders after a patient was discharged. Using a stamp was originally needed for bookkeeping (1893), then a confirmation of registering a patient (1900), and lastly for the health records. Barbara L. Craig calls it “the introduction of business techniques” [17,105,106,107].

In the United States in 1898 the medical notes created by doctors by the bedside of patients were considered complete health records in today’s understanding, instead of just notes for educational purposes. Professor Walter Bradford Cannon (1871-1945) was a pioneer when it came to teaching students (in Harvard Medical School) using health records, in the same way as law records were used to teach in Harvard Law School [4,102].

However, health records were still very limited, as they included a family interview, eating habits, used drugs, prior illnesses, the present illness information, the results of the physical examination, the analysis of blood and urine samples, concise tips about the everyday treatment, and the final diagnosis. The data were often dispersed between wards and ambulatories. Finding particular cases proved to be problematic and dependant on the memory of the records’ author. The situation was similar in private medical practices [109,110].

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Looking at the medical archives from 1810-1932 in the New York Hospital (NYH) it can be noticed that the amount of available records was gradually rising, as pointed out by Ryann L. Engle during his research on palsies and atonies [96].

At the end of the 19th century and at the beginning of the 20th health records in some of the medical centres in Europe and the US began resembling the ones created today, when it comes to their structure. It enabled the information a medical practice had on a particular patient to be found just by using one's personal data. Many institutions got involved in improving the efficacy of the health records system, one of them being the Rockefeller Foundation [4].

The Rockefeller Foundation considered the health records system to be a crucial element in enhancing the quality of the healthcare system and the medical education, as pointed out in the 1910 Abraham Flexner Report [111].

Henry S. Plummer (1874-1937) is considered to be the first person who solved the problem of "dispersed data", by applying a single record to each person, just the way it had been conducted in business and industry. The revolution took place in 1907 in St. Mary's Hospital and Mayo Clinic in the US. The health records were still relatively incomplete compared to the modern ones, mainly because of the lack of the epicrisis [4,112].

In the mid-60s in the 19th century handwritten diagrams of life parameters, fever cards, pulse, and breath measurements and interestingly urine diagrams were becoming increasingly common. Their form depended on the author. The diagrams also made it easier to measure the appropriate levels of morphine needed in peritonitis. The Medical Register became fully formal when NYH opened a new building, and since 1877 all the health records have been supervised and stored [96].

Introducing universal history of the present illness forms and diagrams at the beginning of the 20th century became common practice. It was a result of applying some of the models already used in economics that had proved to be effective, such as displaying information in a graphic form. Stanley Reiser described the new arrangements being introduced to Massachusetts General Hospital [113,114,115].

Ever since 1880 the health records in the US and Europe have become a subject in the matters of insurance and of possible abuse in this regard. Along with the development of medical insurance, health records were becoming increasingly significant. In the United Kingdom, an act from 1911 regarding social insurance, mandatory for working men between 16 and 70 years old, required their medical records to be kept to a certain standard. A system of envelopes and colour-coded cards was introduced and used until 1970 [4,96,116,117].

Based on the available sources, it is impossible to establish whether Europe was the first place where the health records' problem was fully solved. Due to the cultural dominance Europe had over the US before the First World War, a simple transfer of American medical procedures to the Old Continent seems unlikely. The ultimate answer to this question requires more research [17].

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In 1916 in the US, there was a recommendation of writing down the basic information about the illness in a standardised form (an archetype for modern ICD 10). In 1918 the American College of Surgery decided that registering all patients in all hospitals in order to better monitor their treatment and compare the results was a necessity. It proved to be at least partly effective, however, the health records were often illegible, which constrained the advantages of the program [96,118,119]. Around that time, the importance of medical records was becoming apparent. Joel D. Howell, who described the modern hospital as an institution, considers health records to be a part of modern medical technology. It was assumed that the growing amount of documentation would engage more employees, and that more diagnostic and therapeutic procedures would be introduced. According to Joel D. Howell, the growing specialisation encouraged the development of the more professional health records [107].

Stefan Timmermans and Marc Berg claim that for some American surgeons it was important to show that doctors affiliated with the academic environment had higher qualifications than those without them. To prove their point, the surgeons were implementing the gathered medical records. In 1919 the American College of Surgeons began a standardisation campaign using the "treatment diaries". Every patient's health records had to include: an interview with the physician, all the laboratory tests results, diagnostics, a chronological treatment plan, and daily decursus. Importantly, all the data were being archived. Many hospitals supported the initiative. Offices and administrative networks were created to keep the centralised registers in order. Hospitals started hiring professionals to handle the statistical data derived from the records. According to S. Timmermans and M. Berg the entire process began in the US thanks to the scientific community, and then spread to Europe [120].

From the beginning of the 20th century a new problem has arisen, the presence of spam files creating chaos in clinical reports and observations. The concern about the uncontrolled changes being applied to medical record have been expressed for nearly 100 years now. It became clear that quality checks were needed [4, 102, 121, 122, 123, 124, 125].

The advancements in the health records system were brought on by the Second World War. Some of the algorithms used to organise the medical data are still used by modern computerised systems. However, the records were still paper-based [4, 74].

The digital revolution – the introduction of electronic health records

The drastic changes in conducting the of medical records, a gradual process of introducing electronic health records, began in the 60s. Initially, the data were filled in using punch cards, which proved to be a tedious process. However, it allowed the collected data from diagnostics to be evaluated and for them to be used in research, educational, therapeutic, economic, and administrative purposes in a more efficient way than paper-based documentation [116, 126, 127, 128, 129, 130].

Researching the healthcare entities in the US showed that before 2009 only 10% of American hospitals had a large-scale computer system. The basic health records were still paper-based. In 2009 HITECH (Health Information Technology for Economic and Clinical Health)

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recommended that all the medical centres should obligatorily introduce the health records system [131].

In 2011 nearly 50% of doctors in the US used the electronic health records system, thanks to the improving software and the decrease in expenditure. However, some analysts have still expressed their doubts about the computerised system [132, 133, 134, 135, 136, 137].

Currently around 80% of hospitals and doctor's offices use the electronic health records system, which allowed big databases of patients to be created. These databases serve as sources of information for treatments plans, the modelling of the potential costs, the clearance of medical procedures, and research. A feedback mechanism matches the already functioning databases with searching and analysing programs based on artificial intelligence and vice versa – artificial intelligence aids the creation of new databases [131].

A poll involving a large number of participants showed that half of them thought the electronic health records system to be beneficial, 20% of them said the opposite [4, 136].

The arguments used against the electronic health records system involve it being inadequate for current requirements, its unfriendly interface, and a lower standard compared to those made in business. The huge costs also seem problematic [135, 137].

Currently in Europe the electronic health records system is common but is supported by paper-based elements to a different degree in different countries. One of the flagship examples of introducing a complete electronic medical records system is Estonia, being the most digitalised country in the world. The Estonian society is practically free of paper-based documents, which helps save 2% of GDP annually. There are basically three formal matters that cannot be done online: marriage, divorce, and inheritance cases. In the healthcare system, all the history of the illnesses; the registers, the history of prescribed drugs, the blood type and the results of other tests, are stored on servers. Both the doctor and the patient have complete access to one's health records. Over 150 organisations in Estonia use X-Road, a database for digitalised documents. All the hospitals are connected to the X-Road network. The Estonian National Health Information System was created to replace the scattered paper-based databases. To access the e-health system one needs to have an ID card that is physically inserted into a computer. The system is based on a blockchain technology, which allows the files to be decentralised and used by multiple people at the same time (peer-to-peer network). The blockchain technology is used for storing and distributing information that is then encrypted by algorithms called cryptographic hash functions – it is widely used in online transactions, bookkeeping and handling the medical records [138, 139, 140, 141, 142, 143, 144].

In the light of the ongoing COVID-19 pandemic introducing electronic health records could be especially beneficial in terms of better coordination between hospitals. The symptoms of COVID-19 may seem unrecognisable from common flu, so finding common patterns among larger numbers of patients could improve the process of diagnosing the disease in cases where specialised tests are not easily accessible. The full extent of the pandemic is not known due to various reasons – shortages in tests, tests showing false negative results due to improper administration, asymptomatic cases. Elizabeth Halloran, a biostatistician at Fred Hutchinson

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Cancer Research Center and University of Washington estimates the real number of infected people in the US to be between 5 and 20 times of the official number. Italy's Civil Protection Agency suggests a ratio of 1 confirmed case for every 10 actual infections. With the numbers of potentially infected people varying so significantly, it is difficult to estimate any realistic models for the upcoming months. Electronic health records including the entire histories of present illnesses could give statisticians a better idea of numbers of cases that are actually present in the society. The other advantage would be knowing the patient's history of underlying health issues which he or she might not be fully aware of and which are often critical to estimating whether COVID-19 might pose as a realistic threat to their life. Limiting the amount of paper-based documentation, often written in a close proximity to the patient and passed among the medical staff, could also help minimise the number of potential surfaces contaminated with SARS-CoV-2 [145, 146].

Conclusion

Several authors state that the view we have on medical records today proves the ongoing process of change, and the future systems we will develop may drastically vary from the present one [147, 148, 149, 150, 151, 152].

Drawing conclusions from the past, the traits we value in health records nowadays primarily involve an organised structure and clarity. Health records lacked formalisation for millennia and the modern systematic approach is an achievement of the last 100-150 years. Another crucial aspect is the records' quality. Very often a medical script that took a significant amount of time was later considered useless due to its lack of readability. Many authors say that the quality of medical records can be impossible to grade even by a specialist if the described cases and patients are not known. It is important to keep in mind that the original records were not meant to last for centuries, but some can still recognise their value. The records' worth might have also been influenced by supporters of a specific treatment strategy. Another factor to take into consideration is "the magical power of data" – a big cluster of data that might not be useful at all but can (sometimes purposefully) create an aura of professionalism. The ability to select and analyse data from historical records is crucial [153, 154].

It is important to note that many historical sources treat a history of the present illness as the most valuable educational tool when its data and narrative are well balanced and complement one another. The changes imposed on the records' structure in order to make them more universal forced doctors to adapt their style of writing [96].

The inevitable development of technology and the increasing amount of data might become overwhelming. However, the personal notes written by a doctor and the epicrisis are still necessary to create the history of the present illness. In some legal healthcare systems, the epicrisis is replaced by a letter to a general physician (GP) [155].

The medical records' system varies from the history of medicine itself. While the documentation is comprised of original documents and observations made by physicians, the

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history of medicine is often written by a single person in a form of a closed narrative. The patient's history in a certain hospital is compiled as a single folder or file. If the process is digitalised, only the last saved version of the file is legally binding [17, 95].

In the analysis of the medical records' system presented above, there is no mention of its history in places other than North America and Europe, such as China and India, as it goes beyond this paper's scope [156, 157, 158, 159].

To conclude:

1. Health records, previously used mostly for educational purposes for about 100 years now have acquired a fully formal status.
2. We are currently facing the most revolutionary changes regarding the transformation of paper-based records into electronic ones.
3. The importance of this process is outlined by the president of Estonia Toomas Hendrik (2006-2016): "A more extensive and systematic implementation of e-health solutions will allow us to make the service more flexible, improve the health of people by exercising more efficient preventive measures, increase the awareness of patients and also save billions of euros." [160, 161].
4. Introducing electronic health records could be of great benefit during the COVID-19 pandemic and any potential one after it.

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