DIGITAL CRIMINALISTICS IN THE INVESTIGATION OF CRIMES OF INAPPROPRIATE MEDICAL CARE

CRIMINALISTICA DIGITALĂ ÎN INVESTIGAREA INFRACȚIUNILOR DE ÎNGRIJIRI MEDICALE NECORESPUNZĂTOARE

Constantin PISARENCO
ORCID ID: 0000-0001-5548-4653
Email: constantin.pisarenco@gmail.com
Free International University of Moldova

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***Abstract**: Topic relevance. The digitalization of healthcare has transformed digital forensics into an essential element for investigating medical errors and improper care.*

Research purpose – analysis of the role of digital forensics in investigating these crimes.

Material and methods. Scientific publications, international standards and legislative acts regulating digital forensics in healthcare were analyzed, focusing on the use of electronic medical records, telemedicine systems and medical device data.

Results. Electronic medical records and telemedicine data allow for the reconstruction of the chronology of medical personnel's actions and the identification of errors in prescribing treatment. Digital traces from medical devices record protocol violations and monitor reactions to changes in the patient's condition in real time. Issues related to data integration and the protection of confidential information represent significant barriers to the implementation of digital forensics. However, through the correct integration of digital systems and the training of specialists, the objectivity of judicial investigations can be considerably improved.

Conclusion. Digital forensics improves the objectivity of investigations, but requires standardization and training of specialists.

***Keywords**: digital forensics, electronic medical records, medical errors, telemedicine, data privacy.*

Rezumat: *Actualitatea temei. Digitalizarea sănătății a transformat criminalistica digitală într-un element esențial pentru investigarea erorilor medicale și acordarea necorespunzătoare a îngrijirilor.*

Scopul cercetării – analiza rolului criminalisticii digitale în investigarea acestor infracțiuni.

Material și metode. Au fost analizate publicații științifice, standarde internaționale și acte legislative ce reglementează criminalistica digitală în sănătate, concentrându-se pe utilizarea fișelor medicale electronice, sistemelor de telemedicină și datelor dispozitivelor medicale.

Rezultate. Fișele medicale electronice și datele de telemedicină permit reconstituirea cronologiei acțiunilor personalului medical și identificarea erorilor în prescrierea tratamentului. Urmele digitale de la dispozitivele medicale înregistrează încălcări ale protocoalelor și monitorizează reacțiile la modificările stării pacientului în timp real. Problemele legate de integrarea datelor și protecția informațiilor confidențiale reprezintă bariere semnificative pentru implementarea criminalisticii digitale. Totuși, prin integrarea corectă a sistemelor digitale și formarea specialiștilor, se poate îmbunătăți considerabil obiectivitatea investigațiilor judiciare.

Concluzie. Criminalistica digitală îmbunătățește obiectivitatea investigațiilor, dar necesită standardizare și formarea specialiștilor.

Cuvinte-cheie: *criminalistică digitală, fișe medicale electronice, erori medicale, telemedicină, confidențialitatea datelor.*

Introduction

Digital forensics, which is the process of collecting, analyzing and documenting data stored on electronic devices, has gained particular importance in the context of medical investigations. Modern digital technologies are actively penetrating the healthcare industry, transforming all aspects of medical practice, from medical record keeping to patient diagnosis and treatment processes [1]. The introduction of electronic medical records (EMRs), telemedicine systems and digital equipment for diagnosing and monitoring patients has opened up new opportunities for improving the quality of medical care, but at the same time this expansion of the technological arsenal has led to the need to revise approaches to investigating offenses related to improper provision of medical services.

One of the most significant aspects in modern medical error and negligence investigations is the presence of digital traces that are stored in electronic systems. The sources of such traces can be both EMRs and telemedicine systems that capture messaging and data from remote consultations, medical device recordings, and data from patients' personal devices

(e.g., smart health monitoring devices). These digital footprints represent a critical piece of evidence because they provide objectivity and accuracy in determining whether medical error or negligence has occurred and whether the actions of medical personnel met accepted standards [2].

Electronic medical records represent the primary source of digital evidence because they record every interaction a patient has with health care providers. These data include records of procedures ordered, diagnoses, test results, and medication prescriptions. In addition, EMRs capture timestamps of all actions, which allows for accurate sequencing of events and assessment of the timeliness of health care providers' actions. For example, in the case of delayed care, EMC data can confirm or refute the fact that medical personnel did not act within standard time norms [3].

The development of telemedicine, particularly active during the COVID-19 pandemic, has also brought significant changes to the delivery of health care [4]. Telemedicine systems allow physicians to consult patients remotely, increasing the availability of health care services. However, these systems record all interactions, including videoconferences and text exchanges, making it possible for this data to be used in the event of investigations into errors or inappropriate actions. For example, if a doctor disregarded the results of tests provided by a patient, this can be proven based on the records of telemedicine platforms. However, such data pose new challenges in terms of privacy protection, as the information is stored in cloud-based systems that may be under the jurisdiction of other countries [6].

Digital medical devices such as ventilators, cardiac monitors and diagnostic systems are also valuable sources of digital evidence. These devices not only support patients' vital functions, but also record all data about their actions and patients' condition in real time. For example, if medical personnel did not follow protocols for the use of medical equipment, data from these devices can demonstrate discrepancies between prescribed procedures and actual actions. This provides objectivity in investigations and helps identify errors that can have serious health consequences for patients [7-9].

Given the increasing number of crimes and errors related to improper medical care, developing better investigative techniques using digital forensics becomes a critical challenge [6, 7, 8]. In this regard, the aim of the study was to investigate the role of digital forensics in the investigation of offenses related to improper provision of health care.

Material and methods

A wide range of sources were analyzed, including academic publications, international standards, and legislation governing the application of digital forensics in healthcare. Special attention was paid to the study of international practices. The study was based on an interdisciplinary approach that combined methods from digital forensics, medicine, law, and data analysis.

Results and discussion

Digital forensics in healthcare is an interdisciplinary field that integrates medical and information technology to more effectively investigate medical errors, negligence, and other medical malpractice. This field extends traditional approaches to evidence collection by providing access to objective, documented, and detailed data stored in electronic medical systems. Unlike outdated methods such as witness testimony and paper documents, digital forensics offers significantly more accurate and verifiable data that can be used in litigation.

One of the key advantages of digital forensics is its ability to capture and preserve digital traces of all actions of medical personnel. These traces include treatment appointments, use of medical equipment, and even interactions with patients via telemedicine platforms. Digital traces, such as time stamps of doctors' and nurses' actions, allow us to analyze the accuracy of adherence to medical protocols, timeliness of care, and identify potential errors in diagnosis and treatment. For example, if medical personnel failed to adhere to established time standards or made an error in prescribing treatment, the data can serve as key evidence in an investigation [5].

The theoretical framework of digital forensics is based on key concepts such as digital footprint, evidence preservation, and digital data analysis. One of the most important components of this framework are timestamps that are recorded at each stage of a healthcare professional's interaction with a patient. These tags allow the reconstruction of an accurate chronology of events from the time a patient is hospitalized to discharge or transition to another stage of care. This is particularly important in cases where there is a need to assess whether care was provided in a timely manner and to establish a causal link between the actions of medical personnel and the patient's health consequences [3].

With the capabilities of digital forensics, if attempts to alter or delete data are detected, it becomes possible to recover the original records. This plays a key role in investigations where there is suspicion of falsifi-

cation or cover-up of errors by medical personnel. For example, if a doctor or other medical staff member attempts to erase failed actions from electronic records, a digital trace of such actions remains in the system and can be used as evidence of tampering. This increases data security and reduces the risk of manipulation by providing a high level of confidence in the digital evidence [1].

Electronic medical records (EMRs) are an integral part of the digital health infrastructure and serve as a critical source of digital evidence during medical malpractice investigations [10]. EMRs provide a complete and comprehensive record of a patient's interactions with healthcare providers, from medical history, appointments, diagnosis, and treatment, to test results, medical procedures, and prescribed medications. This data provides a comprehensive and objective analysis of the actions of healthcare providers, making it a key piece of evidence in medical error and malpractice investigations.

Of particular importance in these records are the time stamps that record the exact time of each action. This makes it possible not only to reconstruct the full chronology of events, but also to determine the time intervals between the prescription of treatment and its execution. For example, if a physician failed to make a timely decision on a necessary diagnosis or treatment, EMR data can serve as decisive evidence that compliance with the standards of care was violated [3]. In one such case, EMR data provided evidence of a delayed surgery that led to a worsening of the patient's condition.

Through the use of electronic data storage systems, access to information for analysis, audit and control purposes is greatly facilitated. This reduces the risk of information loss, which remains a key concern with paper-based medical records. Automated data storage and backup systems minimize the likelihood of information loss, making EMRs a reliable source for later litigation. There have been many cases in court practice when it was data from EMRs that allowed to reconstruct the chain of events and to confirm or deny the allegations of the parties [1].

The development of telemedicine systems, especially active during the COVID-19 pandemic, has been a significant step forward in expanding the capabilities of digital forensics [11]. Telemedicine allows physicians to consult patients remotely using video and text communication platforms. These systems not only increase access to care for patients in remote areas, but also create additional sources of digital data. Recordings of video and text interactions between doctor and patient can be

stored and used as evidence in medical malpractice investigations. For example, in the case of misdiagnosis, consultation progress data, video recordings, and messages can help identify flaws in symptom analysis or erroneous actions on the part of the physician [6].

However, with the proliferation of telemedicine, new challenges have emerged, especially with regard to data privacy and security. Many telemedicine systems run on cloud platforms whose servers may be located outside the country where the medical service is provided. This creates legal complexities as different countries have different laws governing the protection of personal data and access to medical information. Privacy issues are becoming increasingly important, especially in cross-border interactions and information sharing [5].

In order to fully utilize telemedicine systems and EMC in judicial investigations, it is necessary to create unified standards for the protection of personal data, which will take into account international norms and differences in national legal systems. It is also important to establish a system for regulating access to data for medical investigations while respecting patients' rights to confidentiality. Without addressing these issues, it will be difficult to utilize the potential of digital forensics to its full potential.

Medical equipment with digital functions, such as ventilators, cardiac monitors, defibrillators, and other diagnostic devices, play a critical role in collecting and providing objective data for analysis in malpractice litigation. These devices not only support patients' vital functions, but also automatically record all activities associated with their use. This provides continuous documentation of clinical data, which allows for the reconstruction of a complete picture of the medical staff's actions and the patient's body response in real time.

One of the major advantages of digital medical devices is their ability to capture time stamps of all actions, which greatly facilitates the investigation of potential medical errors or negligence. For example, data collected from a ventilator can show the exact start and end times of ventilation, changes in machine settings, and their compliance with clinical protocols. If the issue of equipment misuse or non-compliance with prescribed standards arises during litigation, this data can provide crucial evidence. In cases where staff have made errors in settings or failed to follow treatment protocols, data from the device can prove the violation and reveal its impact on the patient's condition [12].

Vital signs monitoring systems, such as cardiac monitors and blood oxygen level devices, also play a significant role in investigations. These

systems collect and store data about the patient's condition, such as heart rate, blood pressure, and oxygen saturation. One of the key advantages of these systems is their ability to capture the dynamics of changes in a patient's condition in real time, which makes it possible to analyze how quickly and appropriately medical personnel responded to critical changes in a patient's condition. For example, in cases where the patient's condition has dramatically deteriorated, the data from the monitors can show whether the response of medical staff was timely and whether the necessary measures were taken to stabilize the condition [1].

However, despite the tremendous opportunities offered by digital medical equipment, there are a number of challenges associated with its use [13]. In order to effectively utilize data from medical devices, uniform standards for data collection, storage, and interpretation must be developed and applied. It is important that these data are protected from alteration and manipulation, and that proper and legal access is ensured in case of litigation [5].

Digital medical equipment provides unique opportunities to objectively assess the actions of medical personnel and the quality of care provided. It minimizes the impact of human error on investigations and allows reliance on accurate, automatically recorded data, which significantly improves the process of analyzing medical errors. However, to maximize its effectiveness, it is necessary not only to improve the technology, but also to develop a legal and ethical basis for its use in medical investigations.

Conclusion

Digital forensics has emerged as a critical tool in the investigation of medical malpractice and errors in healthcare. As the healthcare sector increasingly adopts digital technologies such as electronic medical records (EMRs), telemedicine systems and advanced medical devices, the potential to trace the actions of medical staff has expanded significantly. These digital traces provide a more objective, accurate and detailed account of medical interventions than traditional methods such as witness testimony and paper records.

EMRs allow forensic experts to reconstruct the chronology of medical decisions, assess the timeliness of actions, and determine the appropriateness of the care provided. Telemedicine systems provide valuable evidence through recorded consultations, helping to uncover negligence or errors in remote care. Digital medical devices also provide real-time

data on patients' conditions and medical interventions, providing crucial evidence when protocols aren't being followed.

Despite progress, challenges remain, particularly around data privacy, the legal complexities of cross-border telemedicine and the standardization of digital forensics. Ensuring data integrity and securing access to records are key to maximizing the effectiveness of digital forensics in healthcare investigations. The development of international standards and the training of specialists in digital forensics are essential steps towards fully exploiting these technologies while protecting patient confidentiality.

In conclusion, digital forensics holds great promise for improving the objectivity and accuracy of medical investigations. Addressing the challenges of data integration, standardization and privacy will help the healthcare and legal sectors improve the transparency and fairness of medical malpractice investigations.

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