Diagnostic Hysteroscopy Electronic Health Record System

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Abstract.

Introduction: Hysteroscopy is the most frequently performed procedure in gynecology, essential for diagnosing and treating menstrual abnormalities, infertility, suspected endometrial cancer, and congenital uterine anomalies. Diagnostic hysteroscopy lacks a standardized protocol for reporting findings, resulting in inconsistent documentation practices among doctors and hospitals. In Cyprus, but also in a significant percentage of public and private clinics internationally, health records remain paper-based, which hampers efforts to standardize and share health data globally. This situation is untenable in an era where global health data standards are becoming increasingly important for secondary use, cross-system and cross-border communication.

Current Systems: Existing systems for diagnostic hysteroscopy allow for image capture through hysteroscopes. However, the equipment used, is not typically connected to Electronic Health Records (EHR) systems, especially in smaller clinics. The latter introduces a manual process, where healthcare professionals transfer these images and/or videos via external storage equipment (i.e., USB drives) to their personal computers for creating clinical reports. This process is inefficient and prone to errors, highlighting the need for a more streamlined and standardized approach.

Proposed System: We developed a fully customizable add-on module to our Electronic Health Record system but also for any 3rd party EHR solution, that revolutionizes the current processes. The proposed module connects directly to hysteroscopes, capturing medical images and medical video operated via a user-friendly interface and/or voice commands, and then stores them in a database, linked to the patient's profile, thus eliminating the need for additional transfers and hardware. It standardizes the report structure for all users (e.g., doctors), thus allowing for automated clinical report generation, which can be further customized to conform to health insurance organizations' requirements. Importantly, it enables the introduction of additional software as a service (SaaS) AI guidance module(s) based on images/ video during hysteroscopy procedures, while it supports 2nd opinion provision

via real-time and/or on demand medical video streaming[9]. Moreover, the resulting system benefits from the Health Level 7 (HL7) Clinical Document Architecture (CDA) certification inherited from our EHR system, ensuring that it adheres to global health data standards, facilitating international data sharing, interoperability, and aligning and reinforcing the European Health Data Space (EHDS) regulation.

Conclusion This work demonstrates that simple healthcare procedures often overlooked by technology vendors can greatly benefit from novel, customizable interventions. Our EHR system not only makes hysteroscopic data globally accessible but also provides a powerful tool for capturing data to train AI models, ensuring that critical health data is standardized, shareable, and usable on a global scale.

Keywords: Gynecology, Hysteroscopy, Diagnostic Hysteroscopy, Electronic Health Record (EHR), Health Data Standardization, AI-guidance, Image Capture, CDA HL7 Certification, Health Data Interchange, Global Health Data.

1 Introduction

1.1 Gynecology

Gynecology is a specialized field in medicine focusing on the health and diseases of the female reproductive system, including the uterus, ovaries, fallopian tubes, and breasts. This branch of medicine encompasses a wide range of conditions and treatments, from routine health checks and preventive care to complex surgical procedures[4][5]. Gynecologists manage reproductive health, diagnose and treat disorders such as endometriosis, fibroids, polycystic ovary syndrome (PCOS), and cancers of the reproductive organs. They also provide essential services related to pregnancy, childbirth, and menopause, ensuring comprehensive care throughout a woman's life[6][7].

1.2 Health IT & Gynecology

Health Information Technology (Health IT) in gynecology involves the application of advanced information processing techniques, including both hardware and software, to manage healthcare information effectively[2]. This integration of Health IT in gynecology has revolutionized the way patient data is stored, retrieved, and utilized. It has facilitated the digitization of gynecological records, enabling better data management and accessibility. Health IT supports various functions such as electronic health records (EHRs), telemedicine, and decision support systems[3]. These technologies enhance the quality of care by improving diagnostic accuracy, treatment planning, and patient monitoring. Moreover, the use of big data and artificial intelligence in gynecology aids in predictive analytics and personalized medicine, ultimately leading to better patient outcomes.

1.3 Health IT in Cyprus

In Cyprus, the implementation of Health Information Technology (Health IT) faces significant challenges, especially within the field of gynecology. The current healthcare infrastructure relies heavily on paper-based records, impeding the standardization and efficient sharing of health data. This lack of digitization presents obstacles to aligning with global health data standards, which are increasingly critical in the modern healthcare landscape. At the same time, existing systems in Cypriot hospitals for diagnostic hysteroscopy are outdated and inefficient. While hysteroscopes can capture images, the process requires manual transfer of these images via USB to personal computers, followed by report creation using text editors. This manual approach is time-consuming and prone to errors, leading to inconsistent documentation practices among healthcare providers.

These challenges highlight the urgent need for more streamlined and standardized Health IT solutions to improve the efficiency, accuracy, and standardization of medical documentation and data management in Cyprus

2 Current EHR Systems and Hysteroscopy

2.1 Existing Procedures

In Cypriot hospitals, the current systems for conducting and documenting diagnostic hysteroscopies are largely antiquated and inefficient. These systems enable the capture of images via hysteroscopes, which are essential for visualizing the uterine cavity. However, the process for handling these images is cumbersome and somewhat outdated. After capturing the images, doctors are required to manually transfer them from the hysteroscope to their personal computers. Once the images are transferred, reports must be generated manually using text editors. This process involves inserting the captured images into a report format and adding descriptive text to document the findings. The latter process is typically repeated based on different health insurance organizations' requirements.

2.2 Challenges and Motivation

The existing approach to handling diagnostic hysteroscopy data presents several significant problems. Firstly, the manual transfer of images and report creation is a time-consuming process. It requires multiple steps, each of which adds to the overall time taken to complete the procedure and document the findings. Secondly, manual processes are inherently prone to human error. Mistakes can occur during the transfer of images, the input of data, and the creation of reports, leading to inconsistencies and inaccuracies in medical documentation. Importantly, there is no support for video files, posing significant security and privacy concerns to accompanying video files.

Additionally, there is a lack of standardized protocol for reporting hysteroscopy findings, resulting in varied documentation practices among doctors and hospitals. This lack of uniformity makes it difficult to compare data across different institutions and hinders collaborative efforts. The reliance on paper-based health records further complicates the situation. Paper records are difficult to manage, prone to physical degradation, and do not support easy sharing or integration with digital health systems. Lastly, the absence of adherence to global health data standards in the current systems limits the ability to share and utilize health data at an international scale. This is increasingly untenable in an era where interoperability and global data exchange are crucial for advancing research via the secondary use of health data towards improving patient care.

Clearly, there is a pressing need for an advanced, efficient, and standardized approach to diagnostic hysteroscopy documentation. Addressing these issues can significantly enhance the quality of care, streamline workflows, and facilitate the integration of Cypriot health data into the global healthcare ecosystem.

3 Proposed Hysteroscopy Solution

Our cutting-edge Electronic Health Record system integrates advanced Health Information Technology (Health IT) to revolutionize the management and documentation of medical procedures. Designed with a user-friendly interface, it facilitates seamless data capture, storage, and analysis, transforming how healthcare providers manage patient information and conduct diagnostic procedures.

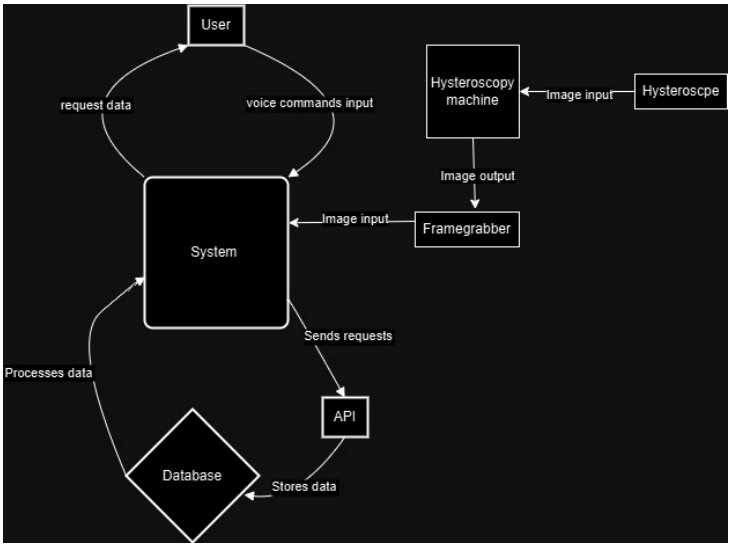

Figure 1 System diagram

3.1 EHR Components and Features

General Characteristics

Our EHR system provides several significant improvements over existing systems. The direct integration and data capture feature of our EHR system connects directly to medical devices such as hysteroscopes, ultrasound machines, cameras and other video equipment, allowing for real-time image and video data capture. This eliminates the need for manual transfers, thus reducing the risk of data loss and errors while speeding up enhancing the healthcare professional experience of interacting with a (single) EHR system. This is achieved by using frame grabbers to get the video output from the medical devices and channel it to our system. This allows us to directly manipulate the data from medical devices as we want and store them directly in our system's database.

The system automates the generation of medical reports, standardizing the report structure across all users. This ensures consistency and accuracy in documentation, which is crucial for maintaining high standards of patient care.

Our EHR provides sophisticated data visualization tools that help healthcare providers quickly interpret and analyze patient data. This includes interactive dashboards that display vital statistics, patient demographics, and treatment outcomes, making it easier to track patient progress and make informed decisions.

Incorporating support for plug and play artificial intelligence modules ranging from predictive analytics such as Intensive Care Unit (ICU) Sepsis prediction, to medical image segmentation and disease classification. This enhances diagnostic accuracy and supports personalized treatment plans.

The system supports International Patient Summary (IPS) and has Clinical Document Architecture certification for Health Level 7 (HL7) standards, ensuring compliance with global health data standards. This facilitates international data sharing and interoperability, which is critical for collaborative research and global health initiatives.
Our EHR system ensures that patient data is secure, with access controls and encryption. It also supports remote access, allowing healthcare providers to access patient information from anywhere, ensuring continuous care.

Unique Hysteroscopy Module Characteristics

The hysteroscopy module within our EHR system addresses several key issues. It addresses the lack of standardization in reporting hysteroscopy findings by automating the report generation process. This ensures that all findings are documented in a consistent format, making it easier to compare and share data.

The module directly connects to hysteroscopes, capturing images in real-time and

storing them in a centralized database. This eliminates the need for manual image transfers and reduces the risk of data loss or mismanagement.

The system not only captures images but also records videos during hysteroscopic procedures. This provides a more comprehensive view of the procedure, aiding in better diagnosis and treatment planning. Furthermore, by embedding in our solution video processing software such as FFMPEG, we allow the user to perform various video-related processes (i.e., compression, resizing, temporal down sampling, etc.). Importantly, we establish the necessary pillars for 2nd opinion provision via real-time and on-demand video streaming of the hysteroscopic procedure, widening the healthcare professional's clinical options, for the benefit of the patient. At the same time, via the setup of a video streaming server, adopting a radiology departments' -like data sharing philosophy, the video recordings can be shared securely, respecting the patient's privacy.

The hysteroscopy module supports voice commands, allowing doctors to capture images and videos without manual intervention. This eliminates delays associated with manual image capture, ensuring high-quality images and videos, and reduces the risk of errors due to interruptions in the procedure. To use voice recognition as well as vocal feedback from the computer to the doctor we used HTML5 Web Speech API that allows us to implement the features we want in almost any browser.

By integrating the hysteroscopy module with the EHR, we streamline the entire workflow from image capture to report generation. This reduces the time taken to document findings and allows healthcare providers to focus more on patient care.

Future modules target AI-driven tools that will assist the medical expert in identifying abnormalities and suggesting possible diagnoses[8]. This will aid doctors in making more accurate, informed and timely decisions during diagnostic hysteroscopies.

With CDA certification, the hysteroscopy module ensures that all data is standardized and can be easily shared with other healthcare institutions globally. This promotes collaborative research and improves the overall quality of care.

By capturing detailed and standardized data, the module provides valuable resources for training new healthcare providers and conducting research. This data can be used to train AI models, further enhancing diagnostic tools and techniques.

4 Conclusion

Our EHR system shows how using advanced technology in healthcare can greatly improve efficiency, accuracy, and data management. One example of this is the hysteroscopy module, which highlights the advantages of automating and standardizing

medical procedures. By doing so, it guarantees that important health information can be easily accessed and utilized worldwide. This system doesn't just enhance patient care but also serves as a strong foundation for medical research and AI advancement

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