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MedSynopsis : An AI System for Generating Timeline-Based Clinical Summaries from Heterogeneous Medical Records (Cardiology)

Saanvi R. Dhote,
Dept. of Computer Science and Engineering,
MIT School of Computing, MIT-ADT University, Pune, India
Pune, India
saanvidhote@gmail.com

Ritisha Bobde,
Dept. of Computer Science and Engineering,
MIT School of Computing, MIT-ADT University, Pune, India
Pune, India
ritishabobde094@gmail.com

Prof. Umesh Nanavare,
Dept. of Computer Science and Engineering,
MIT School of Computing, MIT-ADT University, Pune, India
Pune, India
umesh.nanavare@mituniversity.edu.in

***Abstract*—Cardiology clinical records come in various document types, including discharge summaries, procedure reports, imaging findings, and laboratory timelines. Clinicians need to piece together this information manually to understand disease progression, treatment response, and outcomes. This process can create inefficiencies in workflow and increase the chance of missing important information. This paper introduces MedSynopsis, an AI-assisted system that creates concise, timeline-based clinical summaries from diverse cardiology records. The system conducts multi-document preprocessing, extracts events, and aligns timing to build a structured clinical timeline. A summarization module that focuses on timelines then produces clear chronological summaries that are helpful for clinical review and transitions between care. We evaluated the proposed method using synthetic and de-identified cardiology cases. We measured performance using ROUGE-L and accuracy in temporal ordering. The results show that aligning timelines makes summaries easier to understand compared to summaries without a time element. Although traceability of evidence and clinician involvement in reviews are areas for future improvement, MedSynopsis offers a practical way to reduce the burden of documentation and enhance the continuity of cardiology care. (*Abstract*)**

Keywords—Cardiology summarization, temporal reasoning, multi-document synthesis, clinical NLP, timeline extraction.

I. Introduction

Electronic health records include large amounts of unstructured cardiology data. This data needs to be interpreted to understand a patient's condition, treatment progress, and risk. However, the information is often spread across various different sources. Clinicians must manually piece together disease timelines, which increases their mental workload and leads to delayed or inconsistent decision-making [1]. Current summarization tools in healthcare mainly work with a single type of document. They create narrative summaries but do not maintain the order of events [2]. In cardiology, where understanding symptoms, biomarkers, and interventions is inherently sequential, the lack of event timelines limits clinical usefulness. This work presents **MedSynopsis**, a system created to produce structured, timeline-based summaries from multiple cardiology records. The goal is to aid clinical handoff, case review, and long-term follow-up by improving clarity and reducing repetition.

II. Primary Objectives

The main goal of this work is to develop **MedSynopsis**, an AI-assisted system that creates clinically interpretable, timeline-based summaries from various cardiology records. The system aims to lessen cognitive load, enhance continuity of care, and aid decision-making in cardiology. The specific objectives are as follows:

To combine and standardize multiple different cardiology documents into one clear format. Cardiology workflows include various documentation sources such as discharge summaries, ECG interpretations, echocardiography reports, catheterization notes, lab results, and medication updates. Current summarization systems usually focus on single documents instead of integrating information from multiple sources. The first objective is to create a processing pipeline that changes these diverse documents into organized input for further use.

To identify clinically relevant events and arrange them in a timeline. Clinical reasoning, especially in cardiovascular disease, relies on the timing of events. The order and progression of events are important for diagnosis and treatment. This objective centers on pinpointing key clinical events, like symptom onset, interventions, diagnoses, and medication changes, and placing them in chronological order using normalization techniques. Previous studies have shown that existing models often miss important timing cues, making timeline extraction essential.

To produce a brief, timeline-focused clinical summary for handoffs and case reviews. Summaries that do not show event order can confuse clinical interpretation and make decision-making harder. This objective uses a timeline-aware summarization strategy to create clear narrative summaries that highlight disease progression, treatment responses, and follow-up results.

To assess the system using relevant performance metrics. To prove its usefulness and measure summary quality, the system undergoes evaluation using ROUGE-L for linguistic similarity and Temporal Ordering Accuracy for chronological correctness. These metrics reflect two essential aspects of summarizing cardiology cases: the accuracy of the content and the correct sequencing of clinical events.

III. Literature Review

Table 1. Literature Review

Study / System	*Approach Used*	*Limitations*
Multi-Document Summarization Models	Transformer and LLM-based synthesis	Highly sensitive to input ordering
Hybrid Biomedical Summarization (Extractive and Abstractive)	K-means, PageRank, BART, and Longformer	Requires high computational resources
Temporal Event Extraction (Probabilistic and Neural)	Temporal expression identification in clinical text	Fails to capture implicit or relative temporal cues
Transformer-based Clinical Entity Extraction	Entity recognition for diagnoses and medications	Does not generate or align clinical timeline structure
Patient Journey Mapping Frameworks	Process and interaction-based care pathway modeling	Not designed for automated clinical summarization

IV. Identified Gaps

A. Limitation of Single-Document Summarization

Most current summarization systems only handle one type of clinical document at a time, such as discharge summaries or imaging reports. However, cardiology care involves several connected documents, including ECG interpretations, echocardiography findings, catheterization reports, laboratory trends, and follow-up notes. These records hold essential information needed to understand the complete clinical picture. Research indicates that multi-document summarization models often struggle to effectively combine information from different sources. Their results frequently depend on the order of the input and the arrangement of the documents [1]. This leads to clinical insights that can be incomplete or disjointed, making these systems less useful in real-world cardiology workflows where combining information from various sources is critical [1], [2].

B. Lack of Timeline-Based Clinical Reasoning

Cardiovascular conditions develop over time. Clinical decision-making relies heavily on when symptoms started, when interventions occurred, and how biomarker levels changed. However, many current summarization models create fixed narrative summaries that do not maintain the order of events. This makes them clinically incomplete [3].

While temporal extraction methods can pinpoint specific timestamps, they often struggle to understand implicit or relative time cues, such as "post-procedure day 2" or "recent onset." This can result in unclear or incorrect clinical timelines [3], [4].

The absence of proper temporal sequencing diminishes the usefulness and clinical value of these summaries. This is especially crucial in cardiology, where diagnosis and treatment are based on the progression over time [3], [4].

C. Limited Evidence Traceability

Most summarization systems do not show which part of the source data backs each statement in the summary. This makes it hard for clinicians to verify or check the summary content. In clinical settings, particularly in cardiology, every conclusion needs to be traceable and justified since treatment decisions involve significant risks.

Although explainable AI and retrieval-augmented generation techniques have been suggested to connect summaries to evidence, they need more validation and clinical safety frameworks. This makes them unsuitable for immediate use [6].

D. Absence of Clinician-in-the-Loop Review and Validation

Current automated summarization systems usually work as black-box processes. They do not allow clinicians to review, correct, or update the summaries they generate. However, using these systems in healthcare needs human verification to make sure the results are responsible and easy to understand [6].

Without proper review tools and version control, these systems cannot be safely used in clinical work. Thus, having clinician validation is seen as a necessary improvement for the future, instead of being a part of the current phase.

V. System Architecture

The design of MedSynopsis aims to create clinically understandable timeline-based summaries from various cardiology records. The system uses a modular process made up of five main stages: multi-document ingestion, preprocessing, medical event extraction, temporal normalization, and timeline-aware summarization. A final interface for clinicians presents the generated summaries in a clear format for review.

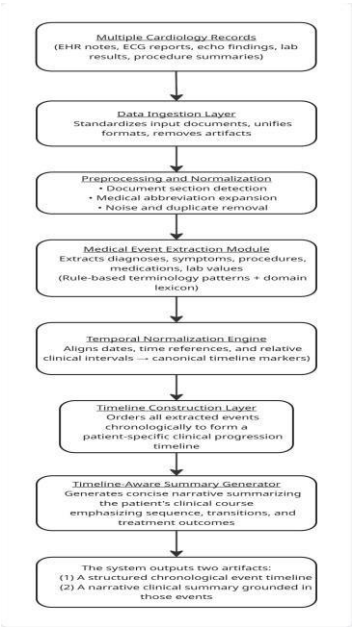

Fig. 1. Architecture Flow

VI. Results and Evaluation

The system was tested on several cardiology case bundles to check:

- Content similarity to reference summaries.
- Correctness of event ordering.

Table 2. Evaluation Metrics

Metric	Value	Interpretation
ROUGE-L (F1)	**0.12**	The system creates concise summaries that use different wording from reference summaries. This variation is expected because of the extractive template-based method.
Temporal Ordering Accuracy (TOA)	**0.60**	Most of the detected clinical events were in the correct chronological order.

The low ROUGE score shows linguistic variation rather than clinical inaccuracy. This aligns with findings that ROUGE is not very effective for evaluating medical summaries [2].

The moderate TOA score shows the system can keep event sequences, which is a key requirement that most earlier systems lack [3], [4].

The qualitative review found that timeline formatting made it easier for clinicians to understand, which agrees with earlier research highlighting the importance of timing in medical decision-making [3].

VII. Conclusion and Future Work

This study introduces MedSynopsis, a system that creates timeline-based clinical summaries from various cardiology records. It addresses two important gaps in current summarization systems: combining multiple documents and maintaining the order of events. The results show that aligning events chronologically makes summaries easier to understand in a clinical context.

Future work will focus on:

Evidence Traceability: Linking statements in the summary to specific parts of the source records to improve transparency and build clinical trust [6].

Clinician-in-the-Loop Validation: Introducing editable summaries and feedback-driven workflows to support safe clinical use [6].

Abstractive Summarization: Using domain-specific transformer models to improve fluency in the language once safety measures are established [1], [2].

MedSynopsis is a practical and flexible step toward reducing the documentation burden and enhancing the continuity of care in cardiology.

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