

Umjetna inteligencija strukturira informacije – kardiolog donosi klinički smisao

Artificial intelligence structures the information; cardiologists turn it into an art

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Tijekom posljednjih desetljeća način na koji čitamo i konzumiramo informacije prošao je niz značajnih preinaka.¹ Iako učenje kroz tradicionalne izvore ostaje glavni izvor informacija u medicinskoj edukaciji, digitalno doba donosi nove modele konzumacije znanstvene i stručne literature preko kojih format informacije postaje prilagođeniji specifičnoj pretrazi i preferencijama pojedinca te dostupan unutar nekoliko klikova. Kao posljedica digitalnih promjena, često se ističu smanjena usredotočenost i pažnja. Stoga je ispravna ravnoteža između tradicionalnih izvora i digitalnog okruženja važna za optimalnu medicinsku edukaciju.

Jedan od najvećih izazova u kardiologiji jesu velik priljev podataka iz objavljenih kliničkih istraživanja i kontradiktorni rezultati.² U potrazi za odgovorom pretraživanje tradicionalnih *online* baza kao što je *PubMed* tada može potrajati satima, uz nedorečene rezultate. Umjetna inteligencija (AI) u kombinaciji s digitalnim čitanjem promijenila je i način kako pristupamo cjelokupnom medicinskom opusu znanja. Današnji AI alati donose mogućnost brze dubinske analize teksta s identifikacijom ključnih pojmova i argumenata, a mogu i generirati tekstualni sadržaj na temelju unaprijed naučenih modela.³⁻⁵

Svrha je ovog uvodnika prikazati kako umjetna inteligencija mijenja interpretaciju kardiološke literature. Na primjeru uređene digitalne arhive časopisa *Cardiologia Croatica* prikazana je pretvorba kvalitetnog repozitorija pohranjenih radova u edukativni medicinski alat s naprednom semantičkom tražilicom, konverzijskim AI agentom, kronologijom razvoja teme unutar opusa časopisa, kliničkim prikazom slučajeva i interaktivnim karticama znanja.

In recent decades, the way we read and consume information has undergone a number of substantial transformations.¹ Although learning by using traditional sources remains the primary means of acquiring knowledge in medical education, the digital era has introduced new models for accessing scientific and professional literature, enabling the format the information is presented in to be tailored to specific search queries and individual preferences while remaining accessible within only a few interactions. However, as a consequence of the digital transformation, reduced attention span and diminished focus are frequently highlighted concerns. Therefore, achieving an appropriate balance between traditional sources and the digital environment is essential for optimal medical education.

One of the greatest challenges in cardiology is the vast influx of data generated by published clinical studies and the often contradictory nature of their findings.² When searching for answers, navigating traditional online databases such as *PubMed* may require hours of effort and still yield inconclusive results. Artificial intelligence (AI), in combination with digital reading, has fundamentally changed the way we access the entire body of medical knowledge. Contemporary AI tools enable rapid, in-depth analysis of textual content through the identification of key concepts and arguments, while also being able to generate textual content based on previous model training.³⁻⁵

The aim of this editorial is to describe how artificial intelligence is changing the interpretation of cardiology literature. Using the curated digital archive of the *Cardiologia Croatica* journal as an example, we illustrate the transformation of a high-quality repository of published articles into an educational medical platform equipped with advanced semantic search capabilities, a conversational AI agent, thematic chronology tracking across the journal's corpus, clinical case presentations, and interactive knowledge cards.

Tradicionalno prema digitalnom čitanju kardiološkoga članka

Temelj svakoga akademskog ili stručnog rada počiva na sustavnom i temeljitom istraživanju informacija. U potrazi za rezultatima novog istraživanja kardiolog danas rijetko ima priliku čitati tiskani oblik medicinskog časopisa. Umjesto toga koristi se internetom i alatima čija je svrha olakšati i ubrzati proces pretraživanja – tražilicama, *web*-preglednicima koji donose kratak prikaz sažetaka, *online* bazama podataka te alatima koji se služe metodama i pristupima AI-ja. Digitalno čitanje danas podrazumijeva i interaktivne prikaze, edukativne kartice slučajeva, pregled kronologije objavljene teme i sl. Prednosti digitalnih alata iskorištavaju se i na brojne ostale načine, poput nekih časopisa koji generiraju infografske prikaze za svaki članak, *podcast* intervjue s autorom rada, audiočitanje objavljenih članaka, dok u isto vrijeme korisnici sve više sudjeluju u javnim raspravama na digitalnoj grupi *#CardioTwitter*.⁶⁻⁹

Više je prednosti nego nedostataka digitalnog čitanja kardiološkoga članka. U dinamičnom, digitalnom okruženju koje karakteriziraju formati HTML ili PDF (najčešće istovjetna kopija tiskanog izdanja) najveći je nedostatak okomito listanje pogotovo kod priloga koji su oblikovani u više stupaca. Zbog visoke razine distrakcije na zaslonu ili ekranu, pamćenje je informacija pri digitalnom čitanju kratkoročno i fokusirano samo na bitne činjenice. Prednosti digitalnog čitanja uključuju brže pretraživanje, prikaz podataka koji omogućuje interaktivne videozapise, brzinu diseminacije, bolje upravljanje referencama i umrežavanje znanja. Upravo te prednosti razlog su zašto kardiolozi čitaju časopise u digitalnom okruženju.¹⁰⁻¹³

Napredni AI alati danas transformiraju digitalno čitanje kardioloških članaka iz pasivnog pregledavanja teksta u interaktivnu i visokoučinkovitu analizu. Njihova uporaba može brzo sažeti i pojednostavniti prikaz rezultata istraživanja, pružiti pomoć pri uređivanju teksta ili generirati nove obrazovne materijale. Istraživanja pokazuju da primjena AI alata ima i ograničenja, poput pogrešne interpretacije rezultata („halucinacije“), generiranja netočnog bibliografskog zapisa i sl. pa je stoga potrebno provjeriti izvore informacija i točnost odgovora AI modela prije primjene u stvarnom životu.¹⁴⁻¹⁶

Kada kardiološki članak progovori

Kvalitetno uređena digitalna arhiva časopisa *Cardiologia Croatica* postala je u proljeće 2026. godine nešto više od repozitorija radova. Jasno određena i urednički oblikovana arhiva od 2124 XML datoteka koja postoji od 2014. godine¹⁷, s pomoću generativnog AI modela, pretvorena je u pretraživ i edukacijski uporabljiv sustav koji mijenja dosadašnji način na koji se kardiološko znanje prenosi, usvaja i kritički procjenjuje (**slika 1**). Umjesto odgovora koji je u tražilici do 2025. godine bio leksički (klasična tražilica ključnih riječi), sada napredna biomedicinska tražilica razumije medicinski kontekst i korisnikovu namjeru. Pristup „razgovora s časopisom“ semantičkom pretragom s pomoću AI modela (**slika 2**) pomaže korisniku da brže pronađe sve relevantne rezultate (**slika 3**), ali i da lakše razumije kako se pojedina tema razvijala u časopisu (**slika 4**). Vektorsko pretraživanje (traženje relevantnosti i konteksta) uz redukciju šuma (nevažnih podataka) ključne su metode kojima se koristi model AI-ja za

Traditional versus digital reading of a cardiology article

The foundation of every academic or professional work lies in the systematic and thorough examination of information. When seeking the results of new research, contemporary cardiologists rarely have the opportunity to read printed versions of medical journals. Instead, they rely on the Internet and various tools designed to facilitate and accelerate information retrieval, including search engines, web browsers that provide brief summary previews (snippets), online databases, and tools powered by AI-powered conversational tools. Today, digital reading also includes interactive visualizations, educational case cards, chronological overviews of specific topics, and similar features. The advantages of digital tools are exploited in numerous additional ways, with some journals generating infographic summaries for each article, podcast interviews with authors, and audio versions of published manuscripts, together with increasing user participation in public discussions through digital communities such as *#CardioTwitter*.⁶⁻⁹

Digital reading of cardiology articles offers more advantages than disadvantages. In the dynamic digital environment characterized predominantly by HTML and PDF formats (often representing an identical copy of the printed edition), vertical scrolling represents one of the main limitations, particularly in articles formatted in multiple columns. Owing to the high level of on-screen distraction, information retention during digital reading is often short-term and focused primarily on key facts. Conversely, the advantages of digital reading include faster information retrieval, enhanced data presentation through interactive multimedia content, rapid dissemination of knowledge, improved reference management, and more effective knowledge networking. These benefits largely explain why cardiologists increasingly consume journal content in digital environments.¹⁰⁻¹³

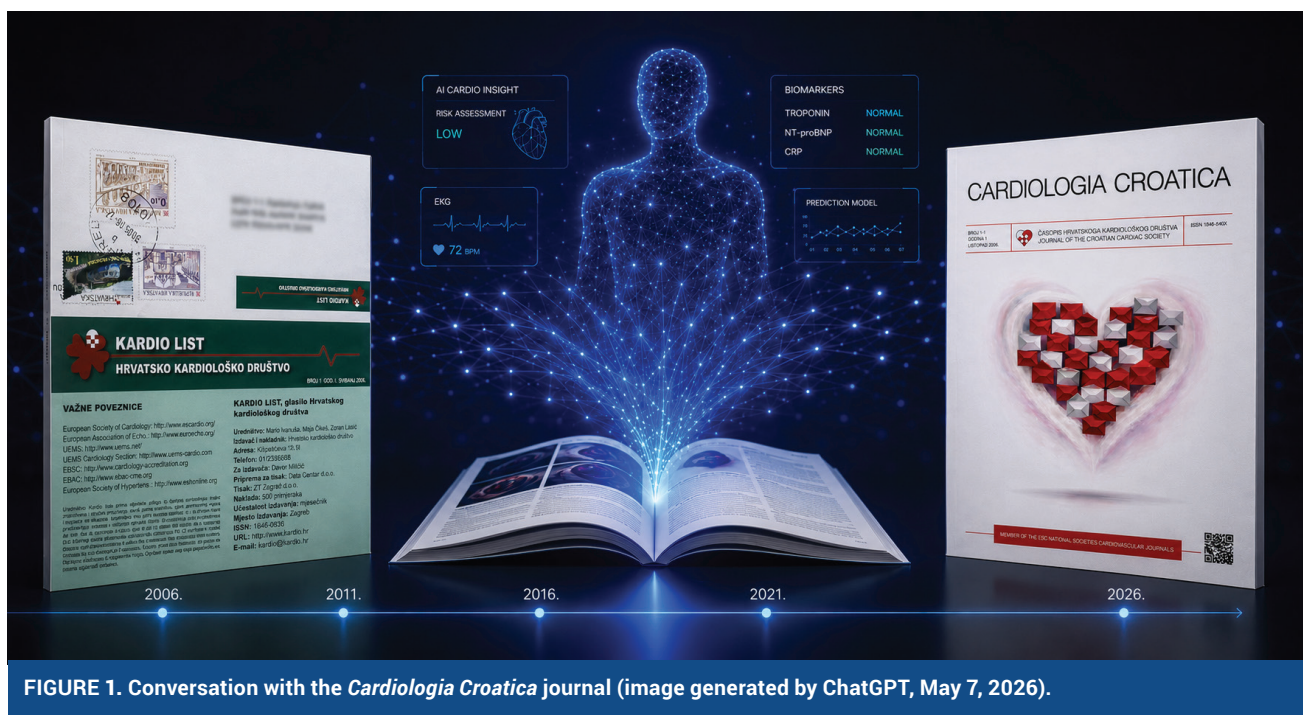
Advanced AI tools are now transforming digital reading of cardiology articles from passive text consumption into an interactive and highly efficient analytical process. Their application can rapidly summarize and simplify research findings, assist in manuscript preparation and editing, and generate novel educational materials. However, studies have also identified important limitations in the application of AI-based tools, including the misinterpretation of results (“hallucinations”), the generation of inaccurate references, and related shortcomings. Consequently, verification of information sources and careful assessment of AI-generated outputs remain essential before their application in real-world settings.¹⁴⁻¹⁶

When a cardiology article speaks

In the spring of 2026, the well-curated digital archive of the *Cardiologia Croatica* journal evolved into something more than a repository of published articles. A clearly structured and editorially curated archive comprising 2,124 XML files, maintained since 2014,¹⁷ was transformed, with the assistance of a generative AI model, into a searchable and educationally valuable system that is changing the way cardiology knowledge is disseminated, acquired, and critically evaluated (**Figure 1**). Whereas search results were lexical in nature until 2025 (i.e., based on conventional keyword matching), the new biomedical search engine powered by advanced AI methodology is capable of understanding medical context and user intent. This “conversation with the journal” approach, enabled through AI-assisted semantic search (**Figure 2**), helps users to not only identify all relevant results more efficiently (**Figure 3**) but also gain a deeper understanding of how a particular topic has evolved throughout the journal’s publication history (**Figure 4**).

točno i brzo pronalaženje relevantnih priloga. Strukturirani filtri suzuju rezultate pretraživanja prema istraživaču, godini, vrsti priloga, DOI i ORCID identifikatorima. Odgovori se oblikuju samo na temelju arhiviranih priloga, uz upućivanje na izvor. U stručnom i obrazovnom kontekstu to je presudno jer korisnik mora moći provjeriti izvor, vratiti se na izvorni članak i koristiti se njime u daljnjem istraživanju, pisanju ili učenju. U edukativnom sloju sustava, uz već spomenutu kronologiju objave, postoje klinički slučajevi i edukativne kartice koje vode korisnika razumijevanju teme, povezivanju izvora i promišljanju o stručnoj literaturi. To je važno jer današnji problem često nije samo dostupnost literature nego preopterećenost informacijama, odnosno snalaženje u velikoj količini dostupnih tekstova.

Vector search methods (identifying relevance and contextual relationships) coupled with reduced informational noise (irrelevant data), represent key methodologies used by the AI model to retrieve relevant content accurately and efficiently. Structured filters allow users to refine search results according to author, publication year, article type, DOI, and ORCID identifiers. Responses are generated exclusively from archived journal content and are accompanied by source references. This feature is particularly important in professional and educational settings, as users must be able to verify sources, access original articles, and incorporate them into further research, writing, or learning activities. In addition to thematic chronology, the educational layer of the system includes clinical case presentations and interactive knowledge cards that guide users toward a deeper understanding of a given topic, enabling users to identify connections between sources and critically evaluate the scientific literature. Such capabilities are important because the primary challenge today often is not limited access to scientific literature, but rather information overload and the difficulty of navigating the large volume of texts in the available literature.



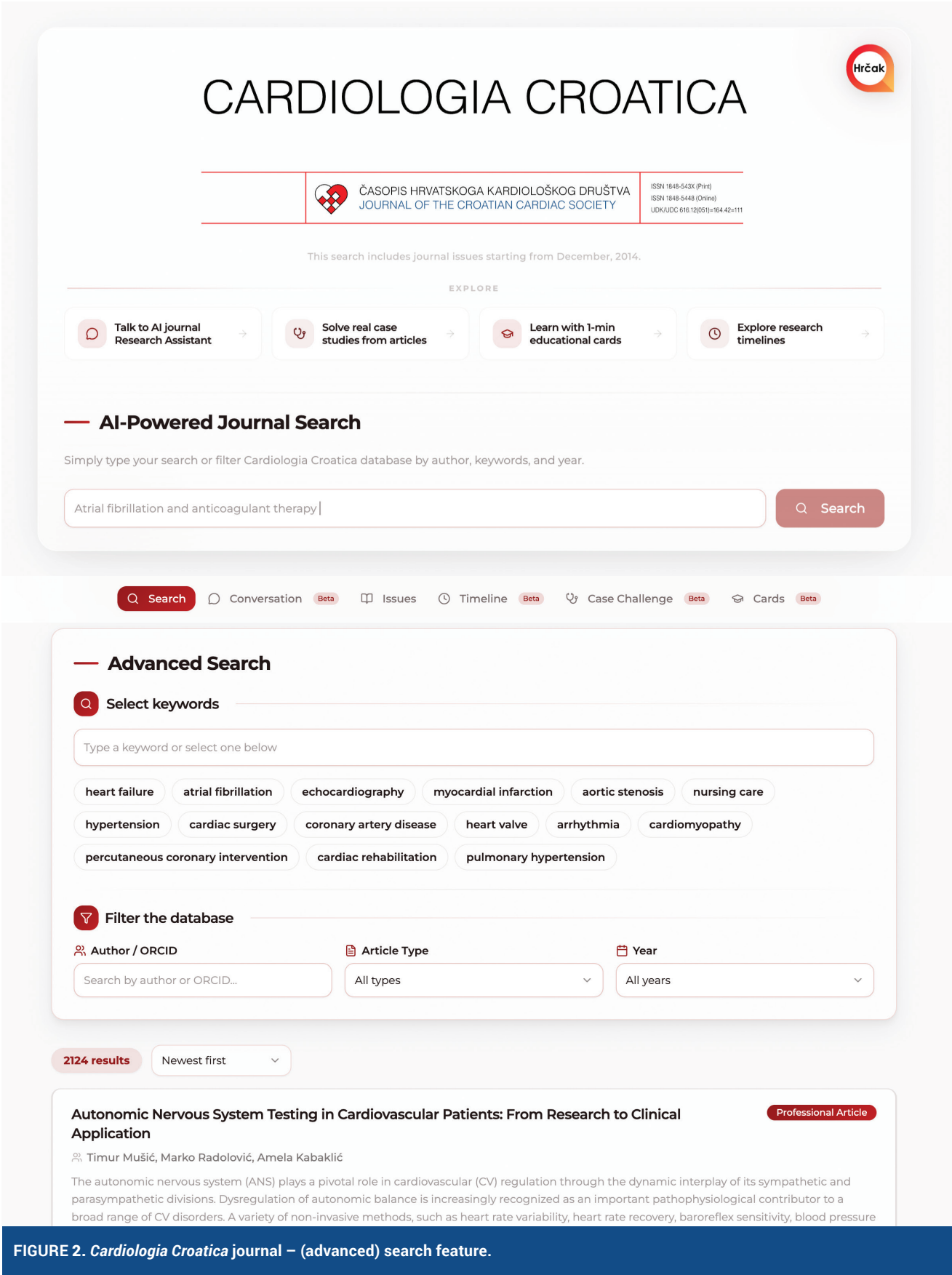


FIGURE 2. Cardiológia Croatica journal – (advanced) search feature.

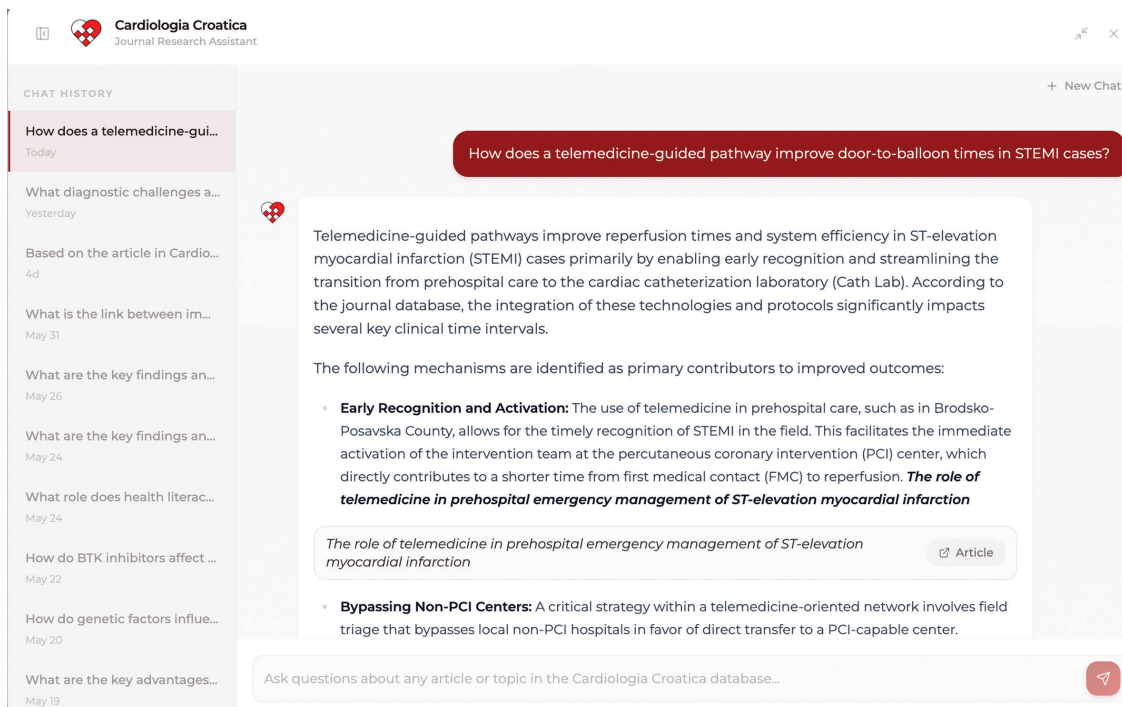


FIGURE 3. Cardiolgia Croatica – AI Journal Research Assistant.

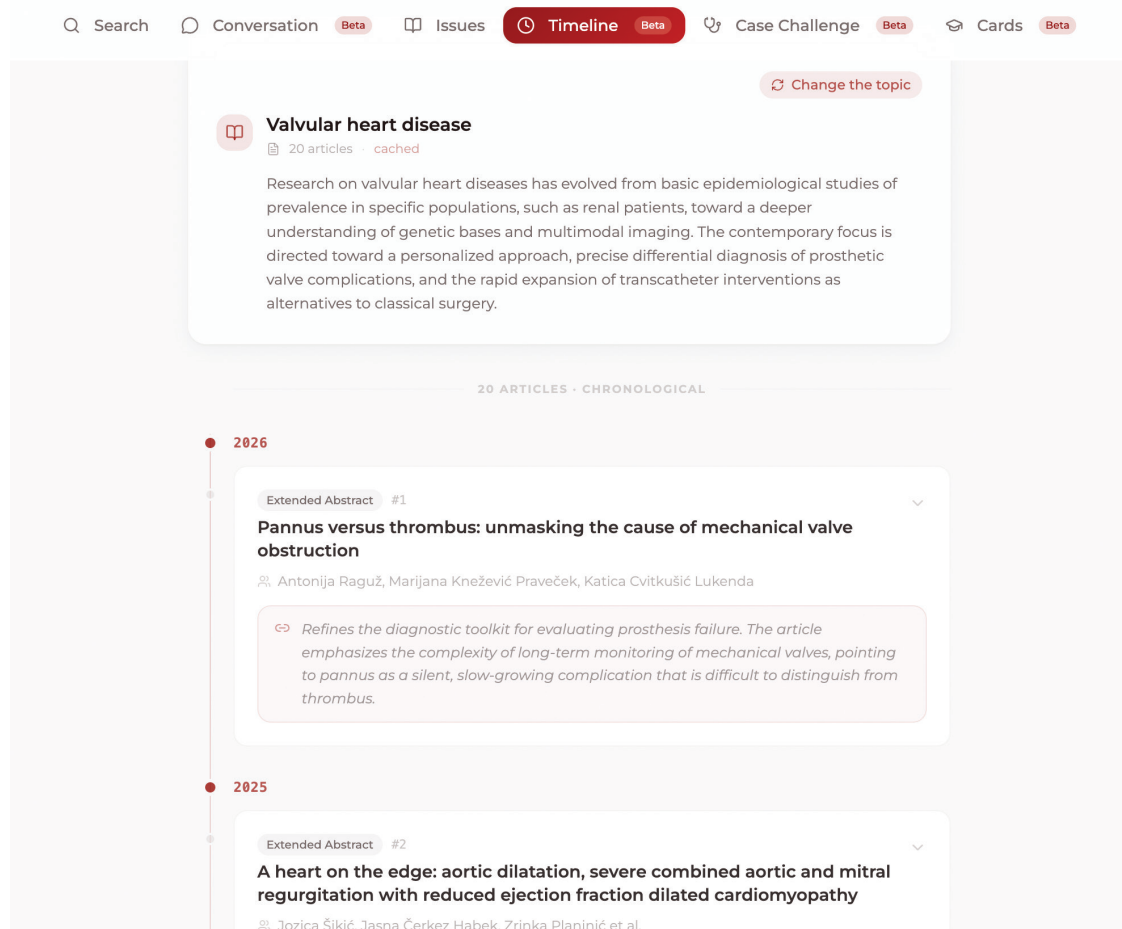


FIGURE 4. Cardiolgia Croatica – Research topic timeline and AI overview of key contributing articles.

Na razini industrije svjedoci smo nekoliko rješenja koja pokušavaju pojednostavniti interakciju s bazama stotinama tisuća časopisa i članaka, što dodatno potvrđuje model i pristup razvijanju. Primjerice izdavačka kuća *Oxford Academic*, koja donosi vodeće časopise Europskoga kardiološkog društva, integrirala je kombinaciju naprednih AI alata modela *OpenAI ChatGPT* i semantičke tražilice kao temelj arhitekture za pretraživanje baza podataka (tzv. RAG tehnologija, prema engl. *Retrieval-Augmented Generation*). *Oxford Academic AI Discovery Assistant* pretražuje baze podataka i smjernica na temelju stvarnoga značenja riječi, a ne samo točnih ključnih pojmova. Pretraživanje se danas provodi ultrabrz i u nekoliko koraka, a RAG arhitektura, odnosno vektorska pretraga, rješava jedan od najvećih problema primjene klasičnih AI alata u medicini – pouzdanost. Najprije se semantičkim pretraživanjem prepozna medicinski kontekst upita, potom se pretražuje baza objavljenih radova i izvlače najrelevantniji odlomci koji se serviraju jezičnom modelu kao jedini dopušteni izvor informacija. Na takav način nema rizika od izmišljanja podataka. Model AI-ja u nekoliko sekundi kreira jasan odgovor na upit, uz navođenje poveznica na objavljeni rad.^{14,15,18} Vektorska i semantička pretraga integriraju se i u citatne baze podataka. Tvrtka *Wolters Kluwer* objavila je *Ovid® Discovery AI* koji omogućuje pretraživanje i filtriranje prema PICO(T) kliničkom pitanju, odnosno metodologiji (populacija, intervencija, usporedba, ishod, vremenski okvir).¹⁹ *AI Discovery* produkt je tvrtke *Elsevier* koji omogućuje dubinsko, semantičko pretraživanje baze *Scopus*, ali donosi i grafički prikaz mreže povezanih pojmova (konceptualna mapa) koji vizualno povezuje srodne istraživačke koncepte i omogućuje shvaćanje širine teme i razvoj novih ideja za pretraživanje.^{20,21}

Zaključak

Implementacija AI modela u diseminaciju znanja znanstveno-stručne publicistike u području kardiologije transformira način na koji se medicinske spoznaje stvaraju, prenose i primjenjuju. Moderno digitalno čitanje pretvara objavljeni članak u interaktivno istraživanje, odnosno pomiče fokus s pasivnog pamćenja na dinamičko zaključivanje. Integracija vizualnih i audioformata omogućuje bržu konzumaciju kompleksnih kliničkih podataka i povećava doseg članka. Ovaj proces može uspjeti samo uz provjerene tehnološke sustave, jasne izvore podataka i visoku profesionalnu odgovornost uredništva.

At the level of the publishing industry, several solutions have emerged that aim to simplify interaction with databases containing hundreds of thousands of journals and articles, further validating this developmental approach. For example, *Oxford Academic*, the publisher of leading journals of the European Society of Cardiology, has integrated advanced AI technologies based on the *OpenAI ChatGPT* models and semantic search tools as the foundation of its database retrieval architecture, commonly referred to as *Retrieval-Augmented Generation (RAG)* technology. *The Oxford Academic AI Discovery Assistant* searches databases and clinical guidelines according to the underlying meaning of terms rather than relying solely on exact keyword matches. Information retrieval moves from hours to seconds with only a few interactions necessary to access any information, while the RAG architecture and vector searches address one of the major limitations of conventional AI applications in medicine – reliability. First, semantic search identifies the medical context of the query, and the system then searches a database of published literature and extracts the most relevant passages, which are supplied to the language model as the sole permissible source of information. This approach eliminates the risk of fabricated content or data. The AI model subsequently generates a clear response to the query within seconds while simultaneously providing references to the original publications.^{14,15,18} Vector and semantic search technologies are also being increasingly incorporated into bibliographic and citation databases. The *Wolters Kluwer* company has introduced *Ovid® Discovery AI*, which enables literature retrieval and filtering based on the PICO(T) clinical questions and methodology (population, intervention, comparison, outcome, and time).¹⁹ *Elsevier's AI Discovery* is a platform that enables deep semantic exploration of the *Scopus* database while also providing graphical representations of interconnected concepts using conceptual mapping, visually linking related research topics and facilitating a broader understanding of a given topic as well as the development of new search strategies.^{20,21}

Conclusion

The implementation of AI models in the dissemination of knowledge from scientific publications within cardiology is transforming the way medical insights are generated, communicated, and applied. Modern digital reading converts a published article into an interactive process of inquiry, shifting the focus from passive memorization toward dynamic reasoning. The integration of visual and audio formats enables faster comprehension of complex clinical data and extends the reach and impact of scientific publications. However, the success of this process depends on reliable technological systems, clear data sources, and a high degree of professional responsibility on the part of journal editors and publishers.

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