Chapter 7
LLMs and Human–AI Collaboration in Healthcare and Research

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ABSTRACT

The rapid evolution of Large Language Models (LLMs) such as GPT-4, Med-PaLM, and BioGPT is reshaping healthcare by transforming how clinical knowledge is generated and applied. This chapter offers an evidence-based analysis of LLMs through technical, ethical, and theoretical lenses, drawing on STS, TAM, and CDST to explain how human–AI collaboration influences clinical practice and governance. It reviews advancements in LLM architectures, multimodal capabilities, and applications in diagnosis, documentation, and biomedical research. Key risks including bias, hallucination, interpretability gaps, and data insecurity are examined within global regulatory frameworks such as the FDA, EU AI Act, and WHO guidelines. The chapter concludes with a Responsible Innovation Framework for Healthcare LLMs (RIF-H), emphasizing anticipation, reflexivity, inclusion, responsiveness, and sustainability. It argues that the future of healthcare AI lies in augmentation, where intelligent systems enhance human expertise, equity, and empathy.

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1. INTRODUCTION AND THEORETICAL FOUNDATIONS

1.1 Context and Importance

The exponential advancement of artificial intelligence (AI) has profoundly reshaped the global knowledge economy, with healthcare standing at the forefront of this transformation. Among the most influential breakthroughs are *Large Language Models* (LLMs) deep learning systems capable of processing and generating natural language with human-like fluency and contextual understanding. Emerging from the success of transformer-based architectures, these models such as GPT-4, Med-PaLM 2, and BioGPT demonstrate unprecedented capability in reasoning, summarization, and knowledge synthesis across diverse domains, including medicine, public health, and biomedical research (Carchiolo & Malgeri, 2025) .

Healthcare, as an inherently data and language-intensive discipline, relies heavily on information exchange, clinical documentation, and evidence interpretation. Physicians, nurses, and researchers continuously generate and interpret large volumes of unstructured data, including electronic health records (EHRs), diagnostic reports, and scientific literature. LLMs offer a mechanism to manage this cognitive and informational complexity by supporting tasks such as clinical documentation, decision support, patient triage, and biomedical literature synthesis. These capabilities hold the potential to alleviate clinician workload, reduce administrative burdens, and enhance the accuracy and accessibility of medical information(Attia, 2025) (Q. Li et al., 2025)

1.2 Evolution of LLMs in Healthcare

The evolution of LLMs can be traced from early symbolic and statistical language models toward large-scale neural architectures built upon the *transformer* framework introduced by (Lyu et al., 2019). Transformer-based models employ self-attention mechanisms that capture long-range dependencies in text, enabling semantic and contextual understanding at scale. Subsequent innovations such as reinforcement learning from human feedback (RLHF), instruction tuning, and multimodal integration further enhanced their adaptability to domain-specific tasks (Q. Li et al., 2025) .

In healthcare, these advances gave rise to a distinct category of **domain-adapted LLMs**, including:

- **BioGPT** (Microsoft Research), trained on biomedical corpora such as PubMed abstracts to assist in scientific writing and drug discovery(Luo et al., 2022).