Chapter 8
Federated Learning and Collaborative AI in Medical Diagnostics: A Conceptual and Literature-Based Study

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ABSTRACT

Advancements in Federated Learning (FL) and collaborative Artificial Intelligence (AI) are reshaping medical diagnostics by enabling hospitals and research institutions to build powerful models without centralized data sharing, as patient information remains on local servers. This section outlines the core principles of FL and the rise of trustworthy, privacy-preserving collaborative AI systems across healthcare networks. It reviews prior work, key techniques, and system designs, explaining how they enhance diagnostic accuracy, efficiency, and personalization. The discussion also highlights real-world applications, emerging trends, and challenges such as interoperability, regulatory compliance, and computational demands. The chapter informs scholars, practitioners, and policymakers on how FL and collaborative AI can transform medical diagnostics and support secure, ethical, and innovative healthcare.

DOI: 10.4018/979-8-3373-7426-0.ch008

1. INTRODUCTION

1.1 The Transformation of Medical Diagnostics Through AI

AI technology has improved medical diagnostics by increasing accuracy, accelerating decision making, and facilitating customized care. Traditional methods are manual and limited to available data which may result to errors and painstaking workflows. On the other hand, AI systems are able to reliably process complex medical data which include images, signals, and medical histories (Alharbe & Almalki, 2025). Deep learning machine models, especially convolutional neural networks (CNNs) and recurrent neural networks (RNNs) have been able to reliably diagnose diseases from scans and other medical signals. These diagnostics aids allow physicians to make informed decisions and early interventions (Roy et al., 2022).

Moreover, AI effectively shifts healthcare from reactive to predictive care by uncovering concealed patterns in large datasets. Such transformations can result in improved patient outcomes and reduced healthcare expenditure. Nonetheless, data privacy and integration issues are barriers to the full potential of AI—most especially the centralized systems. These challenges underscore the importance of privacy preserving collaborative AI techniques such as Federated Learning (Rauniyar et al., 2023).

1.2 Limitations of Centralized AI Models in Healthcare

There are many challenges centralized AI models face in healthcare which could be resolved with implementing these models in Federated Learning systems. One of these challenges is privacy. Restrictions due to data legislations such as HIPAA and GDPR present issues when hospitals need to send patient data to various centralized servers in order to train AI models (Palaniappan et al., 2024).

Centralized systems are particularly susceptible to data breaches. Institutions with servers that contain patient data are exposed to both legal and ethical misconduct, should any of these servers be breached. Furthermore, centralized servers with AI models face challenges due to having siloed information. This single domain bias could negatively impact the outcome of AI models when applied to more heterogeneous patient populations (Aminizadeh et al., 2024).

The final challenge centralized AI systems face is the issue of having data scattered across multiple hospitals and systems. The time and costs needed to collect and standardize such data for centralized use is burdensome. The remaining centralized AI systems are too limited in their scaled application due to the less comprehensive nature of these issues. This sets the stage for solutions with Federated Learning systems.