

LETTER TO EDITOR

The History of Telepathology: Revolutionizing Diagnostics through Remote Communication

Dear Editor,

Telemedicine refers to a health care service that utilizes telecommunications and electronic information technologies to provide health-related services. Telepathology as a subdivision of telemedicine, commonly used by doctors and dentists to aid diagnosis with comprehensive resource to conduct further research and consultation (Anastasio, et al., 2024, pp. 248–250). The main purpose of this paper is to discuss the history of telepathology and its evolution into a potentially game-changing use of tele-diagnostic.

Pathology, the study of diseases, has a rich history dating back to ancient civilizations. Early physicians like Hippocrates and Galen contributed significantly to understanding diseases. The Middle Ages saw pathology influenced by religious beliefs, but the Re-

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naissance revived interest in scientific inquiry. The 17th and 18th centuries saw the invention of the microscope by Antonie van Leeuwenhoek, revolutionizing pathology and histopathology. Rudolf Virchow established cellular pathology, emphasizing disease emergence at the cellular level. Digital technology in the late 20th century led to telepathology (Gupta, Kurc and Saltz, 2022, pp. 1-22).

In 1986, the term "telepathology" was introduced to describe the remote practice of pathology using telecommunications technology to transmit digital pathology images for primary and secondary diagnoses, education, and research. The clinical telepathology services were initially developed in the 1990s, with the inclusion of a nationwide program in Norway. The rapid growth of telepathology in the 2000s was facilitated by advancements in digital imaging and telecommunications technology, resulting in the widespread utilization of diverse systems. Telepathology is now a crucial component of pathology practice, enhancing the precision of diagnoses, enabling remote consultations, and providing easier access to specialized services (Weinstein, Holcomb and Krupinski, 2019, p. 1).

In the present, telepathology has been applied in many fields of pathology, such as surgical pathology, autopsy, cytopathology, and clinical pathology (mostly used in microbiology and hematopathology). Telepathology has been implemented in both developed and developing countries with a wide range of utilization. A study in Germany found that telepathology accurately diagnosed 98.95% of cases using virtual slides, with tumor affection observed in 15.6%. In South Tyrol, Italy, telepathology showed no false positive cases and 85% false negative cases in 2058 consultations using 3,078 frozen sections from 2010 to 2021. A digital pathology system using Aperio GT450 scanning was validated in New York City, allowing 12 pathologists to review and report full pathology cases remotely. A study in Sub-Saharan Africa found portable WSI to be as effective as glass slide microscopy in diagnosing lymphoma, demonstrating its feasibility in resource-limited surgical settings (Krupinski, Bhattacharyya and Weinstein, 2016).

Telepathology has revolutionized tele-diagnostics by utilizing advanced imaging technologies, real-time remote diagnostics, artificial intelligence (AI) integration, improved accessibility, and cost-effectiveness. WSI allows pathologists to scan entire pathology slides at high resolution, enhancing diagnostic accuracy. Virtual Microscopy replaces traditional light microscopy, enabling remote diagnostics. Dynamic telepathology uses robotic microscopes for real-time diagnostics, providing immediate feedback and diagnoses. Advances in telecommunications have reduced delays in diagnosis and treatment. AI-powered image analysis aids in faster diagnoses by identifying patterns and anomalies. Predictive analytics can identify potential health issues before they become critical, improving patient outcomes and streamlining treatment plans. Global reach enables pathologists to provide expertise to underserved and remote areas, ensuring



timely diagnoses. Digital platforms facilitate collaboration, enhancing diagnoses and continuous learning. Cost-effectiveness and efficiency are achieved through reduced travel, logistics costs, and streamlined workflows (Petersen, and Jhala, 2022, pp. 97-98).

Telepathology is a rapidly evolving field, and future development will focus on advanced technologies, patient care improvement, and ethical principles. Advanced imaging technologies, like WSI and AI, can enhance diagnostic accuracy and facilitate remote consultations. Robust internet connections and secure cloud storage solutions are essential for real-time telepathology sessions. Standardizing protocols, providing training, and providing ongoing education will ensure consistency and compliance with data protection regulations. Therefore, health-care facilitators are encouraged to promote interdisciplinary collaboration and invest in research that will further enhance telepathology's potential.

Authors' Contribution

Shiva Shariat contributed to the conceptualization, methodology, and initial drafting of the manuscript. Sukadiono Sukadiono was involved in data collection and the preparation of the original manuscript. Sutrisno Sutrisno provided critical review and revisions, enhancing the intellectual content of the article. Laila Rahmah was responsible for the overall project administration, supervision, and the final review and editing of the manuscript prior to submission. All authors have read and approved the final version of the work.

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Conflict of Interest

None.

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