

Artificial Intelligence in Viral Hepatitis: Advancing Early Detection, Personalized Treatment, and Global Elimination Strategies

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ABSTRACT

Viral hepatitis remains a major global cause of chronic liver disease, cirrhosis, hepatocellular carcinoma, and liver-related mortality despite advances in vaccination, antiviral therapy, and public health interventions. Delayed diagnosis, asymptomatic disease progression, limited healthcare access, and unequal resource distribution continue to challenge the World Health Organization's goal of eliminating viral hepatitis by 2030. Artificial intelligence (AI), including machine learning, deep learning, natural language processing, computer vision, explainable AI, and large language models, has emerged as a powerful clinical decision-support tool capable of improving viral hepatitis management through data-driven analysis. This review highlights the expanding role of AI in early disease detection, laboratory and molecular diagnosis, risk prediction, disease surveillance, medical imaging, fibrosis staging, cirrhosis detection, patient stratification, treatment response prediction, precision medicine, and individualized antiviral therapy. It also discusses AI-driven advances in drug discovery, drug repurposing, virtual screening, protein structure prediction, clinical trial optimization, and radiomics, which have enhanced non-invasive assessment of liver disease and personalized patient care. Although challenges such as limited multicenter validation, data heterogeneity, algorithm transparency, ethical and regulatory concerns, data privacy, and clinical integration remain, continued multidisciplinary collaboration will facilitate the development of robust and explainable AI systems. When responsibly integrated into evidence-based clinical practice, AI has the potential to improve diagnostic accuracy, optimize therapeutic decision-making, advance precision hepatology, and accelerate progress toward the global elimination of viral hepatitis.

KEYWORDS: Artificial Intelligence (AI), Viral Hepatitis, Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), Drug Discovery, Drug Repurposing, Virtual Screening, Radiomics, Machine Learning (ML), Deep Learning (DL), Liver Diseases, Precision Medicine, Antiviral Therapy, Clinical Trials, Hepatocellular Carcinoma (HCC).

INTRODUCTION

Viral hepatitis comprises five hepatotropic viruses: hepatitis A (HAV), hepatitis B (HBV), hepatitis C (HCV), hepatitis D (HDV), and hepatitis E (HEV). Although all primarily affect the liver, they differ in transmission, clinical course, and long-term outcomes. HAV and HEV usually cause self-limiting acute infections, whereas HBV, HCV, and HDV may become chronic, progressing to liver fibrosis, cirrhosis, liver failure, and hepatocellular carcinoma (HCC)^[1]. Despite major advances in vaccination, antiviral therapy, and diagnostics, viral hepatitis remains a leading cause of liver-related morbidity and mortality worldwide^[2]. According to the **WHO Global Hepatitis Report 2026**, approximately **240 million** people were living with chronic HBV infection and **47 million** with chronic HCV infection in 2024, resulting in nearly **1.3 million deaths**, primarily from cirrhosis and liver cancer.

The persistent disease burden is largely due to asymptomatic early infection, delayed diagnosis, limited screening, inadequate healthcare access, poor public awareness, and social stigma, particularly in low- and middle-income countries. To address these challenges, the WHO aims to eliminate viral hepatitis as a public health threat by **2030**, targeting a **90% reduction in new HBV and HCV infections** and a **65% reduction in hepatitis-related deaths** compared with 2015 levels. Achieving these goals requires expanded vaccination, safe blood transfusion practices, early diagnosis, timely antiviral therapy, and effective disease surveillance^[3].

Artificial intelligence (AI) has emerged as a transformative tool capable of rapidly analysing large volumes of clinical, laboratory, and imaging data to identify complex disease patterns. By supporting diagnosis, risk prediction, treatment planning, and clinical decision-making, AI complements clinical expertise and has the potential to improve the accuracy and efficiency of viral hepatitis management^[4].

This review summarizes the global burden of viral hepatitis and highlights the evolving role of AI in disease detection, diagnosis, imaging, precision medicine, antiviral drug discovery, and clinical decision support, while discussing current challenges and future perspectives.

OVERVIEW OF VIRAL HEPATITIS

Viral hepatitis is caused by five hepatotropic viruses—HAV, HBV, HCV, HDV, and HEV—and may present as acute or chronic disease. Acute hepatitis usually resolves within weeks to months, whereas chronic infection persists for more than six months and may progress to liver fibrosis, cirrhosis, liver failure, or hepatocellular carcinoma (HCC)^[5].

HAV and HEV are transmitted primarily through the fecal–oral route via contaminated food or water. These infections are generally self-limiting, although HEV may cause severe disease in pregnant women and immunocompromised individuals. Prevention relies on safe drinking water, improved sanitation, good hygiene, and hepatitis A vaccination for high-risk populations^[6].

HBV, HCV, and HDV spread through infected blood and body fluids, including unsafe injections, unscreened blood transfusions, sexual contact, and mother-to-child transmission. HBV and HCV account for most chronic viral hepatitis worldwide, whereas HDV infects only individuals with HBV, increasing the risk of cirrhosis and HCC.

Clinical manifestations range from fatigue, anorexia, nausea, vomiting, abdominal discomfort, dark urine, pale stools, and jaundice to completely asymptomatic infection. Because chronic HBV and HCV often remain silent for years, many patients are diagnosed only after significant liver damage has occurred^[7].

HBV is highly prevalent in the WHO African and Western Pacific regions, HCV has a global distribution, and HAV and HEV are more common where sanitation and access to safe water are inadequate. Despite advances in vaccination, sanitation, safe blood transfusion, and antiviral therapy, viral hepatitis remains a major public health challenge. Expanding awareness, screening, and timely treatment is essential to reduce complications and achieve the WHO elimination targets^[8].

Fundamentals of Artificial Intelligence in Healthcare

Artificial intelligence (AI) enables computers to perform tasks requiring human intelligence, including learning, reasoning, problem-solving, decision-making, and pattern recognition. In healthcare, AI analyses electronic health records, laboratory data, medical imaging, and genomic information to support diagnosis, clinical decision-making, and patient care while complementing clinical expertise^[9].

Machine learning (ML) enables computers to learn from existing data without explicit programming, whereas deep learning (DL), a subset of ML, uses multilayered neural networks for image analysis, disease classification, and speech recognition^[10].

Natural language processing (NLP) extracts clinically relevant information from electronic health records, clinical notes, laboratory reports, and scientific literature^[11]. Computer vision (CV) interprets medical images, including X-rays, ultrasound, CT, MRI, and digital pathology slides, improving diagnostic accuracy and consistency^[12].

Explainable artificial intelligence (XAI) enhances transparency by providing understandable explanations for AI-generated predictions, thereby improving clinician trust and informed decision-making^[13].

Recent advances in **Generative AI** and **Large Language Models (LLMs)** have expanded applications in literature summarization, medical education, clinical documentation, and medical information retrieval. However, their outputs require expert clinical review before implementation in patient care^[14].

Understanding these core AI technologies provides the foundation for their application in viral hepatitis, including disease detection, diagnosis, treatment planning, and patient management.

Clinical Applications of AI

AI in Early Detection of Viral Hepatitis

Early detection is essential because many patients with hepatitis B virus (HBV) or hepatitis C virus (HCV) infection remain asymptomatic until advanced liver damage develops. Artificial intelligence (AI), particularly machine learning (ML) and deep learning (DL), analyses clinical, laboratory, demographic, and epidemiological data to identify individuals at risk. By simultaneously evaluating variables such as age, sex, liver enzymes (ALT, AST), platelet count, viral load, medical history, and risk factors, AI detects patterns often missed by conventional methods, enabling earlier diagnosis, timely treatment, and improved outcomes^[15,16].

AI-Assisted Laboratory Diagnosis

AI improves laboratory diagnosis by analysing multiple biomarkers, including ALT, AST, bilirubin, albumin, platelet count, prothrombin time, and viral markers, to detect liver injury and distinguish viral hepatitis from healthy individuals. Machine learning algorithms predict disease severity, identify patients requiring confirmatory testing, reduce diagnostic errors, and improve reporting consistency. AI also enables rapid processing of large sample volumes, reducing laboratory workload and supporting early diagnosis in high-volume healthcare settings.

AI in Serological Testing

Serological testing remains the primary method for detecting viral antigens and antibodies such as HBsAg, anti-HBs, anti-HBc, and anti-HCV. AI enhances interpretation by integrating serological results with clinical history, liver function tests, and demographic data to differentiate acute, chronic, and resolved infections. In large-scale screening programmes, AI rapidly identifies high-risk individuals and prioritizes confirmatory molecular testing, improving diagnostic efficiency and reducing healthcare burden^[17].

AI in Molecular Diagnosis

AI enhances molecular diagnostics, including polymerase chain reaction (PCR) and nucleic acid testing (NAT), by analysing HBV DNA, HCV RNA, viral load, genetic variations, and clinical information. Automated analysis improves diagnostic accuracy, predicts disease progression, shortens reporting time, and minimizes human error, particularly in high-throughput molecular laboratories^[18].

AI-Assisted Risk Prediction

AI predicts disease progression by analysing clinical characteristics, laboratory findings, demographics, and medical history. Machine learning models identify patients at increased risk of fibrosis, cirrhosis, and hepatocellular carcinoma more accurately than conventional methods, enabling timely antiviral therapy, closer follow-up, efficient resource allocation, and improved public health planning.

Population-Based Surveillance

AI strengthens hepatitis surveillance by analysing data from electronic health records, laboratory databases, and public health systems. It detects disease trends, identifies outbreaks and high-risk populations, monitors infection patterns, and evaluates prevention programmes, supporting timely intervention, optimized resource allocation, and improved population-level disease management.

AI in Medical Imaging and Liver Disease Assessment

Ultrasound

Ultrasound is the first-line imaging modality for evaluating viral hepatitis because it is safe, non-invasive, inexpensive, and widely available. Artificial intelligence (AI), particularly deep learning, enhances ultrasound by automatically extracting imaging features that may not be detected during routine assessment. AI-assisted ultrasound evaluates liver parenchymal texture, detects fibrosis and cirrhosis, reduces inter-observer variability, and provides objective image interpretation. It also supports early detection of chronic hepatitis-related liver disease and identifies patients requiring further evaluation or treatment.

Computed Tomography (CT)

Artificial intelligence (AI) combined with computed tomography (CT) improves the assessment of chronic viral hepatitis through radiomics, which extracts quantitative image features beyond visual interpretation. By integrating radiomic features with clinical parameters such as liver enzyme levels and coagulation markers, AI enhances the detection of liver fibrosis and cirrhosis, improves disease severity assessment, and supports prediction of hepatocellular carcinoma and other hepatitis-related complications, facilitating long-term patient management.

Elastography

Elastography is a non-invasive technique that measures liver stiffness and is widely used for staging liver fibrosis, offering a safe and repeatable alternative to liver biopsy. Artificial intelligence (AI) improves elastography by automatically analysing liver stiffness measurements and imaging features, increasing the accuracy and consistency of fibrosis staging while reducing observer variability. AI-integrated techniques, particularly shear wave elastography, have demonstrated high diagnostic performance for monitoring chronic viral hepatitis and guiding treatment planning^[19,20].

Histopathology

Histopathological examination of liver biopsy remains the reference standard for assessing inflammation, fibrosis, and other microscopic changes in chronic viral hepatitis. Artificial intelligence (AI) enhances digital pathology by analysing whole-slide biopsy images and automatically identifying features such as fibrosis, inflammatory cell infiltration, and hepatocyte injury. This improves diagnostic reproducibility, reduces inter-observer variability, and supports disease classification and prognosis prediction by detecting microscopic features beyond routine visual

assessment. Although still evolving, AI-assisted digital pathology has shown considerable potential for improving the evaluation of chronic viral hepatitis and other liver diseases^[21].

Fibrosis Staging

Accurate staging of liver fibrosis is essential in chronic viral hepatitis for assessing disease severity and guiding treatment. Artificial intelligence (AI) enhances fibrosis staging by integrating imaging findings with clinical and laboratory data to provide more accurate assessment. Machine learning and deep learning algorithms identify subtle imaging features, classify fibrosis stages, and reduce inter-observer variability, improving diagnostic consistency. AI-based staging also enables early identification of patients at risk of disease progression, facilitating timely antiviral therapy and reducing complications such as cirrhosis and liver failure.

Cirrhosis Detection

Early detection of cirrhosis is critical for preventing liver failure and other complications in chronic viral hepatitis. Artificial intelligence (AI) improves cirrhosis detection by analysing imaging, clinical, and laboratory data to identify advanced liver disease with greater accuracy. AI models using ultrasound, CT, elastography, and other imaging modalities detect cirrhotic changes more consistently than conventional interpretation, reduce observer variability, and support objective clinical decision-making. Early identification enables timely monitoring, treatment planning, and prevention of complications, including portal hypertension and hepatocellular carcinoma^[22].

Patient Stratification

Patient stratification is essential for classifying individuals according to disease severity, risk of progression, and expected treatment outcomes. Artificial intelligence (AI) analyses clinical characteristics, laboratory findings, imaging results, and demographic data to categorize patients into risk groups. Machine learning models identify complex patterns beyond conventional analysis, supporting personalized treatment, closer follow-up, and early intervention for patients at increased risk of advanced fibrosis, cirrhosis, or hepatocellular carcinoma^[23].

Monitoring Disease Progression

Continuous monitoring is vital for assessing treatment response and detecting complications in chronic viral hepatitis. Artificial intelligence (AI) integrates clinical, laboratory, imaging, and follow-up data to identify subtle changes associated with fibrosis progression, cirrhosis, and hepatocellular carcinoma. AI-assisted monitoring supports timely modification of treatment strategies and improves long-term patient management.

Predicting Treatment Response

Predicting treatment response is a key component of personalized hepatitis care. Artificial intelligence (AI) analyses clinical characteristics, laboratory findings, viral markers, and imaging data to estimate individual responses to antiviral therapy. Machine learning models identify complex relationships among multiple variables, enabling

prediction of treatment outcomes, early therapeutic adjustments, and identification of factors associated with treatment success or failure, ultimately improving long-term clinical outcomes^[24].

Precision Medicine

Precision medicine aims to tailor treatment according to an individual's clinical characteristics, disease stage, and biological profile rather than applying a uniform approach. Artificial intelligence (AI) supports precision medicine by integrating clinical, laboratory, imaging, and molecular data to guide personalized treatment decisions in viral hepatitis. By identifying patient-specific disease patterns and predicting disease progression and treatment outcomes, AI enables individualized therapeutic strategies that improve disease management and long-term clinical outcomes.

Individualized Antiviral Therapy

Artificial intelligence (AI) supports individualized antiviral therapy by analysing patient characteristics, viral markers, laboratory findings, and treatment history to identify the most appropriate antiviral strategy^[25]. Machine learning models estimate the likelihood of treatment success and identify patients most likely to benefit from specific antiviral regimens, supporting evidence-based clinical decision-making. Although final treatment decisions remain the responsibility of healthcare professionals, AI serves as a valuable clinical decision-support tool for personalized antiviral management.

Predicting Relapse

Relapse following antiviral therapy discontinuation remains a major challenge in chronic hepatitis B. Artificial intelligence (AI) predicts relapse by integrating clinical data with viral biomarkers to identify patients at increased risk of virological or clinical recurrence. These prediction models support appropriate follow-up scheduling and closer post-treatment monitoring, while complementing established clinical and laboratory assessments.

AI in Drug Discovery and Therapeutic Innovation

Traditional drug discovery is a lengthy, costly, and complex process, often requiring 10–15 years and billions of dollars to develop a single approved drug. Artificial intelligence (AI) accelerates this process by analysing large biological, chemical, and pharmacological datasets to identify promising drug candidates. AI predicts molecular properties, optimizes chemical structures, estimates toxicity, and identifies compounds with therapeutic potential before laboratory testing, reducing development time and cost while improving the likelihood of discovering effective antiviral agents. In viral hepatitis, AI supports the development of safer and more effective therapies against hepatitis B virus (HBV) and hepatitis C virus (HCV).

Drug Target Identification

Drug target identification is a critical step in drug discovery. Artificial intelligence (AI) analyses genomic, transcriptomic, proteomic, and clinical data to identify proteins, enzymes, and molecular pathways involved in disease

progression. Machine learning algorithms uncover biological relationships that may be overlooked by conventional methods. In viral hepatitis, AI identifies viral proteins, such as HBV polymerase, and host immune pathways associated with liver inflammation and fibrosis, facilitating the selection of promising therapeutic targets.

Drug Repurposing

Drug repurposing identifies new therapeutic applications for existing approved drugs. Artificial intelligence (AI) compares molecular structures, gene expression profiles, biological pathways, and clinical outcomes to predict alternative therapeutic uses. Because approved drugs already have established safety profiles, this strategy shortens development time and reduces costs. In viral hepatitis, AI helps identify antiviral and immunomodulatory agents that may improve treatment outcomes or manage HBV- and HCV-related complications.

Virtual Screening

Virtual screening uses artificial intelligence (AI) to rapidly evaluate millions of chemical compounds and predict those most likely to bind specific biological targets. By ranking molecules according to binding affinity, pharmacological activity, and toxicity, AI accelerates lead compound identification while reducing laboratory costs. In viral hepatitis, this approach facilitates the discovery of inhibitors targeting viral enzymes and host proteins essential for viral replication.

Protein Structure Prediction

Understanding three-dimensional protein structure is fundamental to rational drug design. Artificial intelligence (AI) accurately predicts protein structures from amino acid sequences, enabling identification of drug-binding sites even when experimental structures are unavailable. This supports structure-based drug design and the development of targeted antiviral therapies for viral hepatitis.

AI-Assisted Clinical Trials

Artificial intelligence (AI) enhances clinical trials by identifying suitable participants, predicting treatment responses, optimizing trial design, monitoring safety, and analysing clinical data in real time. These capabilities reduce recruitment time, improve trial efficiency, minimize failures, and strengthen treatment evaluation. In viral hepatitis research, AI also helps identify patients most likely to benefit from novel antiviral therapies, monitor treatment response, and predict adverse events, thereby increasing the likelihood of successful drug development and approval^[26].

Current and Emerging Therapies for Viral Hepatitis

Introduction

Viral hepatitis remains a major global health challenge and a leading cause of liver-related morbidity and mortality. Although antiviral therapies have significantly improved outcomes, treatment varies among hepatitis A (HAV),

hepatitis B (HBV), hepatitis C (HCV), hepatitis D (HDV), and hepatitis E (HEV). This section summarizes current therapies, recent advances, and future strategies supporting the World Health Organization (WHO) goal of eliminating viral hepatitis as a public health threat by 2030.

Hepatitis A Virus (HAV)

HAV infection is usually acute and self-limiting; therefore, no specific antiviral therapy is available. Management includes rest, hydration, nutritional support, and avoidance of alcohol and hepatotoxic drugs. Vaccination, improved sanitation, safe drinking water, and good hygiene remain the most effective preventive measures.

Hepatitis B Virus (HBV)

HBV remains difficult to eradicate because covalently closed circular DNA (cccDNA) persists within hepatocytes. First-line nucleos(t)ide analogues (NAs), including **tenofovir** and **entecavir**, effectively suppress viral replication, reduce liver inflammation, and lower the risk of cirrhosis and hepatocellular carcinoma, although lifelong therapy is often required. Pegylated interferon- α (Peg-IFN) offers finite treatment with sustained viral suppression in selected patients but is limited by adverse effects and lower response rates.

Hepatitis C Virus (HCV)

Direct-acting antivirals (DAAs), including **sofosbuvir**, **ledipasvir**, **velpatasvir**, **glecaprevir**, and **pibrentasvir**, have revolutionized HCV treatment, achieving cure rates exceeding **95%** within **8–12 weeks** with minimal adverse effects across multiple genotypes. Challenges include reinfection, antiviral resistance, treatment costs, and limited access in resource-limited settings.

Hepatitis D Virus (HDV)

HDV depends on HBV for replication, making treatment challenging. While pegylated interferon- α has limited efficacy, newer agents such as **bulevirtide**, which blocks viral entry, and **lonafarnib**, which inhibits viral assembly, have shown promising results. Future combination therapies targeting multiple stages of the HDV life cycle may further improve outcomes.

Hepatitis E Virus (HEV)

Most HEV infections resolve spontaneously with supportive care. In immunocompromised patients with chronic HEV infection, **ribavirin** has demonstrated clinical benefit by reducing viral replication and promoting viral clearance.

Emerging Antiviral Drug Development

Current research focuses on novel antiviral targets, immune-modulating therapies, combination regimens, curative strategies for HBV, and improved treatments for HDV and HEV, with the potential to expand therapeutic options and improve long-term outcomes.

Future Directions

Future priorities include developing curative therapies for HBV, optimizing HDV combination therapies, identifying new antiviral targets, expanding hepatitis vaccination programmes, and improving equitable access to antiviral medications, particularly in low- and middle-income countries.

Current therapies have transformed viral hepatitis management, particularly for HCV, where direct-acting antivirals achieve cure rates exceeding **95%**. However, HBV and HDV remain difficult to eradicate because of persistent viral reservoirs and complex replication mechanisms. Continued advances in antiviral drug development, combination therapies, vaccination, and equitable access to treatment will be essential for achieving the WHO goal of eliminating viral hepatitis as a global public health threat^[27].

Current Status of Artificial Intelligence in the Prediction, Diagnosis, and Treatment of Liver Diseases

Artificial intelligence (AI) has transformed hepatology by improving the prediction, diagnosis, treatment, and monitoring of liver diseases. Through machine learning (ML), deep learning (DL), and natural language processing (NLP), AI analyses clinical data, laboratory results, medical imaging, genomic information, and electronic health records to support faster, more accurate clinical decision-making. AI has shown significant value in viral hepatitis, metabolic dysfunction-associated steatotic liver disease (MASLD), liver fibrosis, cirrhosis, and hepatocellular carcinoma (HCC).

Disease Prediction and Diagnosis

AI integrates demographic, clinical, laboratory, lifestyle, and imaging data to identify individuals at high risk and predict fibrosis progression, cirrhosis, hepatic decompensation, HCC, hospital readmission, and mortality. Deep learning models, particularly convolutional neural networks (CNNs), accurately analyse ultrasound, CT, and MRI images to detect hepatic steatosis, fibrosis, cirrhosis, focal liver lesions, and early HCC while reducing inter-observer variability and minimizing the need for invasive liver biopsy.

AI in Viral Hepatitis and Personalized Care

AI supports viral hepatitis management by analysing viral load, liver function tests, imaging findings, and demographic information to predict disease progression and treatment response. It identifies patients at increased risk of cirrhosis and HCC in chronic HBV infection and predicts sustained virological response in HCV, facilitating individualized treatment, continuous disease monitoring, and timely therapeutic modification.

Medical Imaging and Liver Surgery

Medical imaging is one of AI's most successful applications in hepatology. AI-assisted radiomics extracts quantitative imaging biomarkers that improve lesion characterization, tumour staging, prognosis prediction, and treatment

planning. AI also enhances liver surgery and transplantation through anatomical reconstruction, vascular mapping, tumour localization, and prediction of postoperative complications, graft survival, and recurrence risk.

Challenges and Future Directions

Despite its promise, widespread implementation is limited by small datasets, lack of standardized data collection, limited interpretability, privacy and ethical concerns, and insufficient multicentre validation. Future developments will integrate multimodal clinical data, genomics, proteomics, wearable devices, and explainable AI (XAI), together with federated learning and digital twins, to advance precision hepatology through collaborative multidisciplinary research^[28].

Radiomics in Liver Research: A Paradigm Shift in Disease Detection and Staging

Radiomics combines artificial intelligence with CT, MRI, and ultrasound imaging to extract quantitative biomarkers beyond visual interpretation, enabling earlier disease detection, accurate staging, prognosis prediction, and personalized treatment planning.

Clinical Applications

Radiomics enables non-invasive assessment of NAFLD, liver fibrosis, cirrhosis, and hepatocellular carcinoma by analysing tissue texture, shape, intensity, and heterogeneity. It differentiates benign from malignant lesions, predicts tumour aggressiveness, microvascular invasion, recurrence, treatment response, and patient survival, thereby improving personalized clinical management.

AI Integration and Advantages

Machine learning and deep learning algorithms analyse radiomic features to enhance diagnostic accuracy, disease staging, and outcome prediction. Radiomics reduces the need for liver biopsy, provides objective and reproducible measurements, supports personalized treatment planning, and enables continuous monitoring using routinely acquired clinical images.

Challenges and Future Perspectives

Clinical implementation remains limited by variations in imaging protocols, lack of standardized methodologies, limited multicentre datasets, insufficient external validation, and the "black-box" nature of some AI models. Future advances in automated image segmentation, explainable AI, multi-omics integration, and federated learning are expected to establish radiomics as a cornerstone of precision hepatology^[29].

Elimination of Viral Hepatitis by 2030

HBV and HCV remain major causes of liver-related mortality despite effective vaccination and antiviral therapy. The WHO aims to eliminate viral hepatitis as a public health threat by **2030** through a **90% reduction in new infections** and a **65% reduction in hepatitis-related deaths**.

Achieving these goals requires universal HBV vaccination, expanded screening, equitable access to antiviral therapy, safe blood transfusion and injection practices, harm-reduction programmes, and integration of hepatitis services into primary healthcare. Success also depends on public awareness, political commitment, financial investment, and effective surveillance. Continued collaboration among governments, healthcare professionals, researchers, policymakers, and communities will be essential to achieve global elimination targets^[30].

Barriers to AI Adoption in Hepatology

Although AI has considerable potential to improve liver disease management, widespread implementation remains limited by insufficient clinical validation, poor data quality, lack of integration with hospital information systems, limited interpretability, privacy and ethical concerns, regulatory uncertainty, and inadequate clinician training.

Overcoming these barriers requires multicentre validation studies, standardized datasets, seamless integration into healthcare systems, explainable AI models, robust regulatory frameworks, and comprehensive education for healthcare professionals. Addressing these challenges will enable the safe and effective integration of AI into routine hepatology practice^[31].

Conclusion

Artificial intelligence is transforming viral hepatitis management by improving prevention, diagnosis, monitoring, treatment, and therapeutic development. Machine learning, deep learning, radiomics, natural language processing, and explainable AI have enhanced early disease detection, non-invasive fibrosis assessment, cirrhosis identification, hepatocellular carcinoma surveillance, personalized treatment, and prediction of clinical outcomes. AI has also accelerated antiviral drug discovery, drug repurposing, virtual screening, and clinical trial optimization.

Despite these advances, AI should remain a clinical decision-support tool rather than a replacement for physician expertise. Its successful implementation requires high-quality multicentre datasets, rigorous validation, explainable algorithms, standardized clinical workflows, robust ethical and regulatory frameworks, data privacy, seamless healthcare integration, and appropriate clinician training.

Future hepatology will integrate AI with multimodal clinical data, genomics, proteomics, radiomics, digital pathology, wearable technologies, and precision medicine to deliver predictive, preventive, personalized, and patient-centered care. Combined with effective vaccination, universal screening, timely antiviral therapy, and strengthened public health strategies, AI has the potential to improve diagnostic accuracy, optimize therapeutic decision-making, expand

access to quality liver care, and accelerate progress toward the **WHO 2030 goal of eliminating viral hepatitis**, ultimately improving outcomes for millions of patients worldwide.

ABBREVIATIONS

AI – Artificial Intelligence

ML – Machine Learning

DL – Deep Learning

NLP – Natural Language Processing

XAI – Explainable Artificial Intelligence

CT – Computed Tomography

MRI – Magnetic Resonance Imaging

CNN – Convolutional Neural Network

EHRs – Electronic Health Records

HAV – Hepatitis A Virus

HBV – Hepatitis B Virus

HCV – Hepatitis C Virus

HDV – Hepatitis D Virus

HEV – Hepatitis E Virus

HCC – Hepatocellular Carcinoma

MASLD – Metabolic Dysfunction-Associated Steatotic Liver Disease

NAFLD – Non-Alcoholic Fatty Liver Disease

NASH – Non-Alcoholic Steatohepatitis

DAAs – Direct-Acting Antivirals

Peg-IFN – Pegylated Interferon-alpha

NAs – Nucleos(t)ide Analogues

PCR – Polymerase Chain Reaction

NAT – Nucleic Acid Testing

WHO – World Health Organization

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