

Modern Approaches to the Diagnosis and Treatment of Hepatocellular Carcinoma

Alexander T. Vogt*

Department of Hepatology, University of Freiburg, Baden-Württemberg, Germany

ABOUT THE STUDY

Hepatocellular Carcinoma (HCC), the most common primary malignancy of the liver, continues to pose a global health challenge. With rising incidence worldwide, especially in regions with high prevalence of hepatitis B and C, HCC has become a leading cause of cancer-related mortality. Traditionally associated with limited treatment options and poor prognosis, recent advances in the diagnosis and management of HCC have introduced a wave of optimism. From imaging innovations and biomarker development to systemic therapy breakthroughs and personalized medicine, the landscape of HCC care is rapidly evolving. In this perspective, I aim to highlight key developments and suggest future directions that could reshape the clinical approach to this aggressive malignancy.

Improved imaging and early detection

Early diagnosis remains the cornerstone for improving HCC outcomes, as curative treatments such as surgical resection, liver transplantation, and ablation are most effective when the tumor is detected at an early stage. Conventional surveillance strategies, such as ultrasound every six months for at-risk populations (e.g., cirrhotic patients), have limitations in sensitivity and operator dependency. Recent advances in imaging techniques, including Contrast-Enhanced Ultrasound (CEUS), dynamic contrast-enhanced CT and MRI with hepatocyte-specific contrast agents, have significantly improved diagnostic accuracy.

Multiparametric MRI, for example, offers excellent sensitivity in detecting small lesions and differentiating HCC from benign liver nodules. Artificial Intelligence (AI)-driven image analysis and radiomics are emerging as powerful tools that could further enhance diagnostic precision, reduce interobserver variability, and support automated lesion classification. In my view, integrating these technologies into routine practice can revolutionize early detection, especially in settings with limited radiology expertise.

Biomarker innovation and liquid biopsy

While Alpha-Fetoprotein (AFP) remains the most widely used serum biomarker for HCC, its sensitivity and specificity are suboptimal. Recent studies have identified novel biomarkers, including Des-Gamma-Carboxy Prothrombin (DCP), glypican-3, and Circulating Tumor DNA (ctDNA), which offer promise for early detection and monitoring.

Liquid biopsy techniques, involving the detection of tumor-derived materials (e.g., DNA, RNA, and extracellular vesicles) in blood, are gaining traction as minimally invasive diagnostic tools. These assays not only facilitate early diagnosis but also enable real-time tracking of tumor evolution and therapeutic response. From my perspective, the widespread clinical adoption of liquid biopsies could mark a paradigm shift in HCC surveillance and personalized therapy.

Advances in locoregional therapies

For patients with intermediate-stage HCC, locoregional therapies such as Transarterial Chemoembolization (TACE) and Radiofrequency Ablation (RFA) remain critical components of care. Recent innovations have improved the precision and efficacy of these treatments. Drug-Eluting Beads (DEB-TACE), for instance, provide more consistent drug delivery and fewer systemic side effects compared to conventional TACE.

Stereotactic Body Radiation Therapy (SBRT) is another emerging option, offering targeted treatment with minimal damage to surrounding tissues. Additionally, combining loco regional therapies with systemic agents particularly immune checkpoint inhibitors is under investigation and may enhance tumor control. In my opinion, these hybrid approaches should be further explored through well-designed clinical trials to optimize sequencing and patient selection.

The most transformative changes in HCC management have occurred in systemic therapy. Sorafenib a multi-kinase inhibitor, remained the sole approved agent for advanced HCC for over a decade. However recent years have seen the approval of several

Correspondence to: Alexander T. Vogt, Department of Hepatic and Intestinal Research, University of Medical Sciences Berlin, Berlin, Germany, E-mail: vogt.hepatology@unimed-berlin.de

Received: 10-Jan-2025, Manuscript No. JHGD-25-37404; **Editor assigned:** 14-Jan-2025, PreQC No. JHGD-25-37404 (PQ); **Reviewed:** 27-Jan-2025, QC No. JHGD-25-37404; **Revised:** 06-Feb-2025, Manuscript No. JHGD-25-37404 (R); **Published:** 13-Feb-2025, DOI: 10.35248/2475-3181.24.11.344

Citation: Vogt AT (2025). Modern Approaches to the Diagnosis and Treatment of Hepatocellular Carcinoma. J Hepatol Gastroint Dis.11:344.

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new therapies, including lenvatinib, regorafenib, cabozantinib and ramucirumab which have expanded first- and second-line treatment options.

The greatest breakthrough has been the advent of immunotherapy. The combination of atezolizumab (an anti-PD-L1 antibody) and bevacizumab (a VEGF inhibitor) has demonstrated superior survival benefits over sorafenib in the IMbrave150 trial and is now considered the standard of care for first-line therapy in advanced HCC. Other immune-based strategies, including dual immune checkpoint blockade and CAR-T cell therapy are under active investigation.

Multidisciplinary and global perspectives

Managing HCC requires a multidisciplinary approach involving hepatologists, oncologists, radiologists, transplant surgeons, and pathologists. Tumor boards that facilitate collaborative decision-making have proven effective in optimizing patient outcomes. Furthermore, addressing disparities in access to care especially in low- and middle-income countries where hepatitis B and aflatoxin exposure are prevalent must be a global priority.

Equally important is the need for continued public health efforts in prevention, such as hepatitis B vaccination, antiviral therapy for hepatitis C, and lifestyle modifications to reduce the burden of Non-Alcoholic Fatty Liver Disease (NAFLD), a rising risk factor for HCC in Western populations.

CONCLUSION

The diagnostic and therapeutic landscape of hepatocellular carcinoma has changed dramatically over the past decade. Improved imaging, novel biomarkers, and transformative systemic therapies particularly immunotherapy have redefined what is possible for patients with this historically intractable disease. As we stand on the cusp of personalized medicine in liver oncology, it is critical to invest in translational research, global access to care, and the integration of emerging technologies into clinical practice.