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REVIEW

Multidisciplinary Team (MDT)-Based Approaches for Liver Cancer Treatment: A Discussion Paper on Tumor Boards and Beyond

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Abstract: Hepatocellular carcinoma (HCC) remains one of the most common malignancies worldwide. Its high aggressiveness and complex pathophysiology contribute to diverse but often suboptimal treatment outcomes. The Multidisciplinary Team (MDT) integrates expertise from various specialties to provide personalized and optimal treatment strategies for individual patients. However, conventional MDT face limitations related to logistics, consensus-building, and patient communication. This review aims to discuss the current status and challenges of MDT in liver cancer management and explore emerging innovative technologies that can transcend the conventional model.

Keywords: hepatocellular carcinoma, multidisciplinary tumor board, precision medicine

Introduction

Liver cancer ranks as the fifth most commonly diagnosed cancer globally and represents the second leading cause of cancer-related mortality in men.[1] It encompasses primary liver cancer and secondary (metastatic) liver cancer. Primary liver cancer is predominantly classified into three distinct pathological types: Hepatocellular Carcinoma (HCC), Intrahepatic Cholangiocarcinoma (ICC), and combined Hepatocellular-Cholangiocarcinoma (cHCC-CCA). These types differ significantly in their pathogenesis, biological behavior, histopathology, treatment approaches, and prognosis. HCC constitutes approximately 75–85% of all primary liver cancer cases.[2] Colorectal liver metastases (CRLM) are the most common form of secondary liver cancer, with nearly 50% of colorectal cancer (CRC) patients developing metastatic disease in the liver.[3]

The pathogenesis of HCC is highly complex and multifactorial, involving the dysregulation of multiple molecular pathways. This intricate pathogenesis is not only the core reason for the significant heterogeneity of HCC—where tumors vary markedly in molecular characteristics, pathological features, and clinical behavior among patients,[4] but also provides a basis for developing diverse precision treatment strategies tailored to specific tumor profiles.[5,6] The pronounced heterogeneity of HCC has also influenced the design of staging systems.[7,8] The Barcelona Clinic Liver Cancer (BCLC) staging system, widely used internationally, primarily considers HCV infection and alcoholic liver disease as core etiological factors.[9,10] In contrast, the China Liver Cancer (CNLC) staging system, developed within the Chinese context, integrates the fact that Hepatitis B virus (HBV) infection is the predominant cause of HCC among Chinese patients, forming a framework that more closely aligns with domestic diagnostic and therapeutic practices.[11] While the available treatment modalities are diverse and often complementary, forming a comprehensive management system for HCC, a central dilemma persists in clinical practice: how to precisely select the most appropriate treatment for each patient to formulate a truly personalized and optimal therapeutic strategy.

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The Multidisciplinary Team (MDT), is a core collaborative model in oncology based on the concept of "integrated medicine". It brings together specialists from various disciplines—such as Hepato-Biliary Surgeon, Oncologists, Interventional Radiologists, Radiologists, Pathologists, Radiation Oncologists and Hepatologist/Infectious Disease Specialist,[12] to develop individualized and evidence-based treatment plans for cancer patients. The MDT plays an indispensable role in managing complex malignancies like HCC, which are characterized by diverse etiologies, multiple staging systems, and a wide array of treatment options.[13,14] Herein, we first systematically outline the standard operational workflow of a liver cancer MDT. We then analyze potential shortcomings in current MDT practices, highlighting the practical challenges inherent to the traditional model. Finally, we explore emerging technologies and innovative models that are reshaping this field —including the potential application of Artificial Intelligence (AI) and Machine Learning (ML) in optimizing MDT decision-making, and the transformative role of virtual MDT in overcoming the limitations of traditional in-person collaboration—thereby laying the groundwork for a deeper discussion on the future evolution of MDT in liver cancer care.

The Standard: Liver Cancer Tumor Boards in Practice

Core Composition and Roles

Radiologist

As a crucial contributor to precise staging and treatment response evaluation, the diagnostic radiologist performs pre-operative imaging (eg, contrast-enhanced CT, gadoxetate-enhanced MRI, contrast-enhanced US) to establish a diagnosis and stage the disease. They clarify tumor size, number, vascular invasion (eg, portal vein tumor thrombus), and extrahepatic metastasis (eg, lung metastasis), thereby assisting in determining the BCLC/CNLC stage.[15,16]

Pathologist

The pathologist first establishes a definitive pathological diagnosis from pre-operative biopsy specimens, differentiating hepatocellular carcinoma (HCC) from other liver tumors like intrahepatic cholangiocarcinoma (ICC), and assesses tumor differentiation grade (well/moderately/poorly differentiated). Secondly, through biomarker testing[17,18](eg, CTNNB1, TERT promoter mutations) and immunohistochemical markers (eg, GPC3, Arg-1), they provide a molecular basis for selecting targeted/immunotherapy regimens. Finally, for patients undergoing resection, they evaluate the surgical specimen to assess the extent of invasion (eg, capsular breakthrough), presence of vascular/lymphatic tumor thrombi, determine the postoperative pathological stage, and guide adjuvant therapy decisions.[19,20]

Hepatologist/Infectious Disease Specialist

The hepatologist plays a key role in evaluating portal hypertension through clinical assessment and imaging modalities (eg, abdominal ultrasound, hepatic venous pressure gradient measurement) to stratify disease severity. They conduct endoscopic screening for esophageal and gastric varices to identify bleeding risks, with timely intervention (eg, band ligation) when high-risk varices are detected. Additionally, they oversee the overall management of liver disease—encompassing etiological control (eg, antiviral therapy for viral hepatitis, lifestyle guidance for NAFLD)—and implement regular monitoring (eg, liver function tests, imaging surveillance) and long-term follow-up to track disease progression and adjust therapeutic strategies dynamically.[21–24]

Hepato-Biliary Surgeon

As the key decision-maker for curative-intent treatments (surgical resection and liver transplantation), the surgeon primarily formulates treatment plans for very early or early-stage resectable liver cancer. Based on imaging and liver function tests, they assess whether the tumor meets surgical indications (eg, size, location, relationship to portal/hepatic veins, absence of extensive vascular invasion) and evaluate the feasibility of liver resection extent or donor matching for transplantation. They lead the performance of radical liver resection and perioperative management to minimize surgical impact on liver function.[25,26]

Interventional Radiologist

Responsible for local minimally invasive therapies, the interventional radiologist performs ablation (eg, microwave or cryoablation) for early-stage (BCLC Stage 0 and A). For intermediate-stage (BCLC Stage B), they perform transarterial chemoembolization (TACE) or hepatic arterial infusion chemotherapy (HAIC), often combined with targeted/immunotherapy to control local tumors and achieve downstaging. For intermediate-stage HCC unsuitable for TACE and select cases of advanced liver-confined disease, they may perform transarterial radioembolization (TARE).[27–29]

Radiation Oncologist

For early-stage disease in patients ineligible for surgery or interventional therapies, the radiation oncologist utilizes techniques such as stereotactic body radiotherapy (SBRT) to deliver ablative doses, aiming for definitive local tumor control.[30] For advanced disease, they contribute to multidisciplinary treatments through combination strategies—for example, integrating radiotherapy with systemic therapies (eg, targeted agents, immunotherapies) to slow tumor progression, alleviate symptoms and optimize survival outcomes.[31]

Oncologist

Focused on systemic and palliative therapy, the oncologist primarily designs treatment plans—including targeted therapy (eg, Sorafenib, Donafenib), immunotherapy (eg, PD-1 inhibitors alone or combined with antiangiogenic agents), and chemotherapy (eg, FOLFOX4)—for patients with advanced-stage liver cancer (eg, BCLC Stage C) or those at high risk of postoperative recurrence. They also manage treatment-related adverse events (eg, hypertension from targeted therapy, hepatitis from immunotherapy).[15,32]

The Workflow of a Conventional MDT

The workflow of a typical hepatocellular carcinoma (HCC) Multidisciplinary Team (MDT) meeting consists of three sequential phases: the pre-meeting phase (case screening and data preparation), the in-meeting phase (case presentation and multidisciplinary discussion), and the post-meeting phase (consensus documentation and plan implementation). (Figure 1)

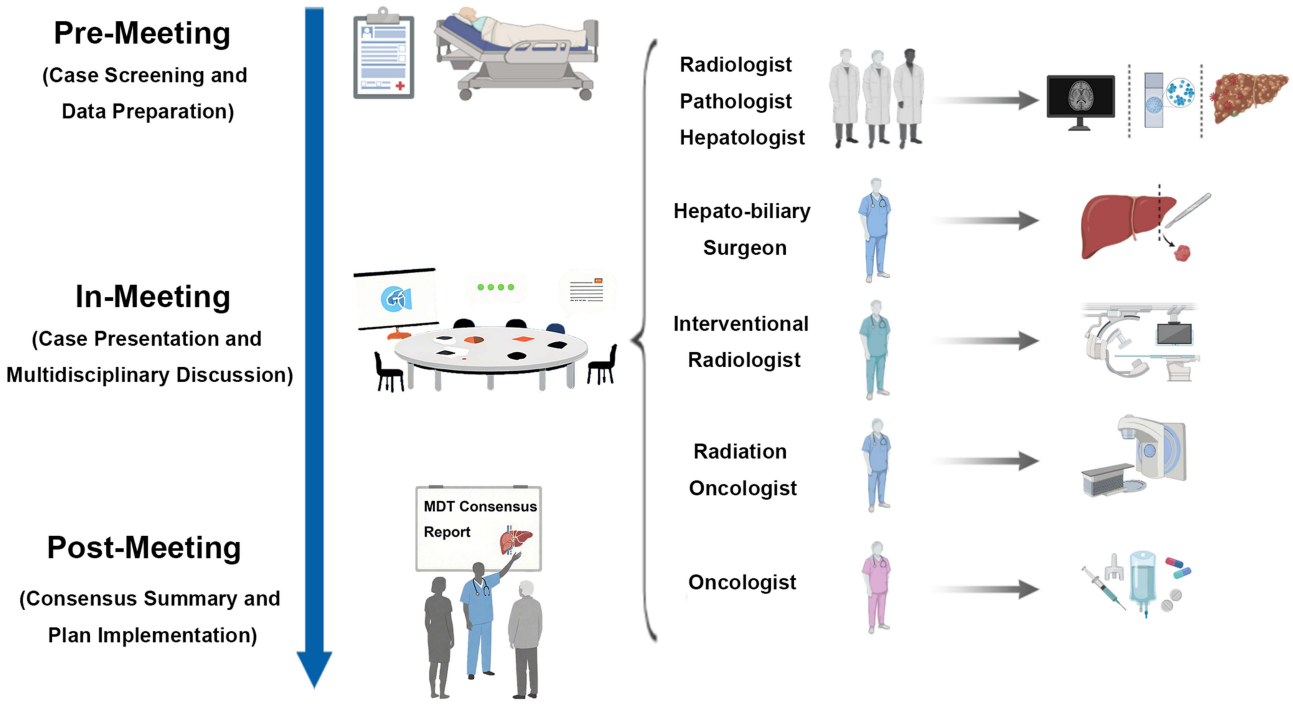

Figure 1 Schematic Diagram of the Entire Workflow for Hepatocellular Carcinoma (HCC) Multidisciplinary Team (MDT).

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Pre-Meeting: Case Screening and Data Preparation (1–3 Days Prior to the Meeting)

The department leading the MDT organizes the meeting. Case selection typically includes: 1) Newly diagnosed HCC patients (requiring definitive staging and initial treatment planning, eg, determining suitability for TACE in BCLC-B stage); 2) Cases with diagnostic or therapeutic dilemmas (eg, choice between resection and ablation for early-stage HCC in a Child-Pugh B patient); 3) Cases with unsatisfactory treatment response or recurrence (eg, disease progression after TACE, considering a switch to a combined TACE plus systemic therapy approach); 4) Complex cases (eg, patients with portal vein tumor thrombus, extrahepatic metastases, or complicating cirrhosis-related conditions).

The patient's managing physician compiles a standardized case report including: 1) Basic patient information: age, gender, past medical history, present illness, and liver function tests (Child-Pugh grade, transaminases, bilirubin, etc).; 2) Relevant investigations: imaging data (reports and access to images from contrast-enhanced CT/MRI, contrast-enhanced ultrasound, noting tumor size, number, and vascular invasion), pathology reports (if biopsy or resection was performed, confirming HCC diagnosis, differentiation grade, and molecular biomarker results), and tumor markers (serial measurements of AFP, PIVKA-II); 3) Questions for discussion: clearly defined key issues for the MDT to address (eg, choice of treatment modality).[33]

The collated materials (including electronic imaging links and PDF reports) are shared in advance via the hospital's MDT coordination platform or Email to ensure experts have sufficient time for pre-meeting review.

In-Meeting: Case Presentation and Multidisciplinary Discussion

The managing physician presents the standardized case summary, highlighting the core history, key imaging/pathology findings, and the specific questions for discussion. Specialists from each discipline then provide expert opinion based on their domain knowledge.

Post-Meeting: Consensus Summary and Plan Implementation

Within 24 hours after the meeting, the MDT secretary consolidates the discussion into a formal "MDT Consensus Report". This report includes: 1) Basic patient information and the key questions discussed; 2) The main opinions expressed by specialists from each discipline; 3) The final consensus treatment plan (specifying the primary treatment modality and the responsible department, eg, "TACE procedure by Interventional Radiology within one week, followed by assessment for targeted therapy by Medical Oncology two weeks post-procedure").

Based on this consensus report, the managing physician explains the recommended plan to the patient and family, obtains informed consent for treatment, and coordinates its execution across departments (eg, liaising with Interventional Radiology to schedule TACE while simultaneously requesting Hepatology to adjust antiviral medication doses).[34]

Efficacy and Limitations of Conventional MDT

A central challenge in liver cancer management lies in its multifaceted nature—treatment decisions must integrate tumor stage (eg, BCLC/CNLC), liver function status (Child-Pugh grade), underlying etiology (HBV/HCV/NAFLD), and the selection and impact of appropriate therapies. A siloed, single-specialty approach is prone to suboptimal decisions due to its limited perspective, whereas the Multidisciplinary Team (MDT) model significantly enhances clinical accuracy and standardization of care through multidisciplinary consensus.[22,35,36] Studies report that HCC patients managed by an MDT, particularly those with intermediate or advanced disease, experience a significantly reduced risk of cancer-related mortality (HR=0.88) and improved overall survival.[21]

This precision extends beyond treatment matching to encompass the entire "diagnosis-staging-treatment-follow-up" continuum. For instance, in the diagnostic and staging phase, the MDT integrates the radiologist's precise assessment via gadoxetic acid-enhanced MRI—a technique that demonstrated an 81.2–83.3% accuracy in guiding treatment decisions in the SORAMIC trial, significantly superior to CT (70.8–73.4%), and which excels at detecting small or satellite lesions.[16,37–39] This imaging is combined with molecular biomarker testing and liver function grading (Child-Pugh) to avoid staging inaccuracies from relying on a single modality, ensuring accurate BCLC/CNLC staging and forming a solid foundation for subsequent therapy.[40,41] At the treatment decision level, the MDT reconciles differing specialty perspectives. For a BCLC Stage B patient, while interventional radiologists might prioritize TACE, the conventional MDT

incorporates relevant assessments—though oncologists often lead in evaluating ECOG performance status, all MDT experts are capable of this evaluation, and it is integrated with the hepatologist's assessment of portal hypertension risk. If the patient is a suboptimal TACE candidate (eg, large tumor burden with mild portal vein invasion), a consensus can be reached for TARE as an alternative, adhering to European guidelines for intermediate-stage HCC and avoiding inappropriate therapy stemming from a single-specialty bias.[42]

Furthermore, MDT facilitates the expansion of personalized treatment boundaries, allowing more patients to access curative options or achieve survival prolongation. For patients initially exceeding the Milan criteria, the MDT can integrate input from interventional radiology (TACE/TARE for downstaging), surgery (transplant assessment), and pathology (response monitoring) to formulate a downstaging strategy. Research by Yao et al showed that patients successfully downstaged within the Milan criteria achieved a 5-year post-transplant survival of 56.1%, comparable to the 63.3% rate in patients initially meeting the criteria.[43] Another multicenter study confirmed a 10-year post-transplant survival rate of 52.1% in successfully downstaged patients, significantly higher than the 43.3% rate in those who remained beyond the criteria.[44] The implementation of such strategies relies entirely on the MDT's dynamic interplay: interventional radiology's assessment of treatment response, surgery's judgment on transplant timing, and hepatology's management of pre-transplant liver function.

The synergistic value of the MDT is even more pronounced in combining systemic and local therapies. For BCLC Stage C patients, the MDT combines the oncologist's selection of systemic regimens with an evaluation by interventional radiology or radiation oncology on the need for consolidative local therapy (eg, ablation for residual intrahepatic lesions, SBRT for portal vein thrombus). For example, an MDT might consensus recommend "immune checkpoint inhibitor plus antiangiogenic therapy" over further local treatment for an HCV-cirrhotic patient with bilobar HCC and prior SBRT/TARE history.[15] The IMbrave150 trial reported a significantly greater benefit for atezolizumab plus bevacizumab over sorafenib, with a response rate of 30% and a median overall survival approaching 19 months in the first-line setting.[45] This shift in strategy avoids the risks of radiation-induced liver injury while leveraging the systemic control offered by modern therapies.

However, the effective operation of an MDT is highly dependent on sufficient funding, personnel, and specialized resources, a challenge particularly acute in liver cancer care. In primary care settings, core specialties essential for HCC management are often lacking.[46] Some hospitals may not have dedicated hepatobiliary surgeons or interventional radiology equipment, making it difficult to include these vital members in the core MDT. Reliance on remote consultation can hinder discussion efficiency and potentially reduce decision-making precision due to communication limitations. Additionally, standardized systems for data collection and quality assessment for HCC MDT are lacking, a problem compounded by the complexity of integrating "multidimensional evaluation metrics".[47] MDT decisions require synthesizing tumor characteristics, liver function, molecular markers, and etiology, yet significant variations exist in how different centers record this data.[36] Perhaps more importantly, aligning multidisciplinary consensus with patient acceptance can present a potential communication barrier. MDT recommendations, often focused on tumor control and survival benefit, may not always fully align with an individual patient's preferences, psychological expectations, or quality-of-life priorities.[48]

"The Beyond": Innovating and Expanding the MDT Concept

In recent years, the widespread application of emerging technologies, such as 5G networks and artificial intelligence (AI), has driven the reform and innovation of the traditional MDT model. It is no longer confined to in-person meetings, creating new possibilities for overcoming geographical barriers, optimizing decision-making efficiency, and transforming doctor-patient communication.

The Digital and Virtual Tumor Board

The Virtual Multidisciplinary Team (vMDT) is an innovative form of the traditional in-person MDT, enabled by digital technology. Its core function is to leverage remote communication and cloud-based collaboration platforms to break geographical constraints, facilitating cross-regional and cross-institutional collaboration among multidisciplinary experts

to develop standardized treatment plans for cancer patients.[49] vMDT applications manifest in two primary modes: Tele-MDT and Asynchronous MDT.

Tele-MDT: Utilizing secure, encrypted cloud-based video conferencing platforms, Tele-MDT breaks down geographical barriers between major cancer centers and primary care or remote medical institutions. This allows cases of HCC patients from primary care settings to be rapidly evaluated by a joint panel of core specialists (eg, hepatobiliary surgeons, interventional radiologists), reducing the time and financial costs associated with patient travel for referrals. It simultaneously enables the dissemination of high-quality specialist expertise.[50,51]

Asynchronous MDT: This mode, based on cloud-based case storage and interactive platforms, enables non-real-time collaboration. The primary care physician can upload the complete medical record of an HCC patient in advance and annotate specific questions. Specialists can then flexibly log into the platform at their convenience to review the case and leave comments. The platform integrates these multidisciplinary inputs to form a preliminary consensus, which is finally confirmed via a brief online meeting. This model addresses the key challenge of "difficult-to-coordinate expert schedules" inherent in traditional MDT and is particularly well suited to the need for long-term follow-up in HCC management.[21,52,]

Empowering MDT with AI

Artificial intelligence (AI) is increasingly playing a vital role in MDT. In imaging diagnosis, AI models analyze patient multimodality fingerprints (MMF)—integrating clinical, radiological, and peripheral immunology features—to effectively differentiate HCC from other focal liver lesions (eg, atypical lesions), thereby reducing misdiagnosis rates.[53,54] For personalized treatment decision support, the Multiparametric Therapeutic Hierarchy (MTH) represents an innovative concept in HCC. It is constructed based on an ordered hierarchical treatment paradigm, multiparameter models, and the concept of inverse hierarchy staging to optimize treatment selection and avoid both over- and under-treatment.[55] AI facilitates this by integrating multimodal data (imaging, genomic, clinical markers) to build predictive models that aid MDT in formulating treatment plans. Compared to guideline-directed therapy, AI-driven predictive models demonstrate superior performance in guiding dynamic treatment strategies.[56] Machine learning algorithms (eg, XGBoost) are being explored to predict treatment recommendations and assist clinical decision-making[55] In prognostic risk prediction, AI-driven 3D reconstruction and volumetry techniques (eg, applying TR LI-RADS criteria) can quantify tumor volume changes, precisely assessing treatment response and disease progression.[57] ML algorithms can integrate clinical, imaging, and molecular marker data to build high-accuracy, multivariate prognostic models encompassing tumor burden, liver function grade, and treatment response, enabling predictions of 1-year and 3-year survival rates.[58,59] Furthermore, AI models can identify high-risk features like microvascular invasion, providing early warning of postoperative recurrence and optimizing follow-up strategies.[56,60]

Integrating Patients into MDT

Innovation in HCC MDT extends beyond technology and process to a shift in the care model—from "disease-centered" to "patient-centered". Shared Decision-Making (SDM) is recognized as a core component of HCC management.[61] For patients with stable disease and good cognitive function, the MDT can selectively invite them to participate in parts of the discussion. This helps patients understand the MDT's recommendation and, more importantly, can increase determinants of treatment confidence, such as health literacy and the patient's perception of the decision-making process.[48] The fact that some patients decline MDT-recommended therapy, often due to misalignment with patient preferences, suggests that incorporating the patient's perspective can improve acceptance of the proposed plan.[34] A large-scale study showed that while HCC patients managed by an MDT experienced a longer diagnosis-to-treatment interval, they had a significantly reduced risk of cancer death (HR=0.88), particularly those with intermediate-advanced disease;[21] this implies that patient involvement may enhance confidence in the treatment plan, thereby improving adherence.

Strategies for Patient Privacy Protection and Risk–Benefit Balance

In the clinical practice of multidisciplinary team (MDT) management for liver cancer, the protection of patient privacy and dynamic balance between risks and benefits are among the core elements throughout the process.

Measures for patient privacy protection include three aspects: 1. Standardization of data desensitization: All patient data involved in MDT diagnosis and treatment discussions as well as research analysis must undergo strict desensitization procedures—removing direct identifiers such as names, ID numbers, and medical record numbers, replacing them with anonymized codes or virtual identifiers. Meanwhile, indirect identifiers like age and native place are processed through data obfuscation techniques to reduce the risk of privacy leakage from the source.[62,63] 2. Hierarchical control of access permissions: In research scenarios such as constructing predictive models with machine learning, it is necessary to integrate multi-source clinical data and implement strict hierarchical control of access permissions: only authorized researchers registered through ethical review are granted access, and only desensitized retrospective cohort data are made available. Additionally, real-time tracing of data usage trajectories through operation logs forms a full-process traceable permission management loop.[64] 3. Collaborative management of biological samples: For the collection and use of biological samples such as tumor tissues and blood, standardized norms for the entire "collection-storage-access" process are established: informed consent forms must be signed to clarify the scope of use before sample collection; during storage, a management mode where sample numbers are decoupled from clinical data is adopted; clinical information associated with samples can be used in research in conjunction with samples only after approval by the ethics committee, ensuring that each step complies with privacy protection norms.[65]

Based on the principle of "precision in diagnosis and personalization in treatment", dynamic risk–benefit balance is implemented in stages: 1. Risk control and benefit optimization in the diagnostic stage: Primary physicians lead the integration of multi-modal imaging examinations (eg, CT, MRI, contrast-enhanced ultrasound) and selectively combine pathological biopsy, tumor marker detection, and other methods to form diagnostic opinions, achieving the optimal balance between "economic cost and diagnostic efficacy". Relevant research data show that relying solely on MRI as a second-line diagnostic tool may lead to 16% of liver cancer patients being missed and 6% of false-positive patients receiving unnecessary invasive treatment, which not only increases the risk of treatment-related injuries but also causes waste of medical resources.[66] 2. Personalized balance in treatment decision-making: MDT needs to establish a dual-dimensional evaluation system of "disease characteristics-patient willingness", comprehensively considering the patient's underlying liver disease status (eg, presence of cirrhosis), tumor staging (eg, BCLC staging), and treatment expectations (eg, priority on survival time or quality of life). For example, in advanced liver cancer patients, systemic therapy with targeted drugs combined with radiotherapy can extend median survival by 3–6 months, but it is necessary to evaluate compensatory capacity based on Child-Pugh liver function classification and predict in advance toxic risks such as hypertension and hand-foot skin reactions related to targeted drugs. The final plan is determined through doctor-patient shared decision-making.[67,68]

Conclusion

In the field of hepatocellular carcinoma management, the value of MDT is undeniable. This collaborative model reduces the limitations of single-specialty decision-making, improves adherence to clinical guidelines like BCLC and CNLC, and for patients with intermediate-advanced disease, this multidimensional collaboration translates directly into survival benefits, contributing to improved prognosis. As healthcare systems evolve towards greater accessibility, efficiency, and precision, the future of HCC MDTs lies in constructing a Hybrid Model. This model would maintain periodic in-person meetings as a foundation while simultaneously establishing an AI-powered virtual MDT (vMDT) platform. Leveraging AI's capabilities for imaging analysis and data integration, this hybrid approach can break down geographical barriers to provide cross-regional expert support for primary care institutions, rapidly elevating their HCC management standards. Concurrently, it can offer an efficient consultation channel for post-treatment patient follow-up, shortening the decision-making cycle. It is foreseeable that with the widespread adoption and continuous innovation of this integrated "online + offline" MDT model, the MDT will further push the boundaries of traditional care, playing an even more critical supporting role in the entire lifecycle management of liver cancer and becoming a central pillar in advancing high-quality HCC diagnosis and treatment.

Author Contributions

Writing original draft and editing: Mengdi Qi (First author). Supervision and Project administration: Min Qi (Corresponding author). All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

All authors declared that there are no conflicts of interest.

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