JOURNAL OF INTERNATIONAL CRISIS AND RISK COMMUNICATION RESEARCH
ISSN: 2576-0017
2023, VOL 6, NO S4

The Role of the Oncology Nurse in Hepatocellular Carcinoma Management in Saudi Arabia

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Abstract

Hepatocellular carcinoma HCC is a leading cause of cancer-related mortality worldwide, with a particularly high burden in the Saudi Arabia. The pathogenesis of HCC is multifactorial, with chronic hepatitis B virus HBV and hepatitis C virus HCV infections being the primary risk factors. Other contributing factors include cirrhosis, alcohol consumption, aflatoxin B1 exposure, advanced age, male gender, obesity, and diabetes. The complex interplay between these risk factors creates a pro-carcinogenic environment that promotes the development and progression of HCC. Despite the availability of various interventions, the prognosis for HCC remains poor, emphasizing the importance of prevention and early detection. Universal HBV vaccination, particularly in endemic regions, is the most effective strategy for reducing HCC incidence. Additionally, public health measures targeting other modifiable risk factors, such as alcohol consumption, obesity, and diabetes, are crucial. Surveillance and screening programs utilizing ultrasonography and serum alpha-fetoprotein testing are recommended for high-risk individuals to facilitate early detection. The management of HCC requires an individualized approach based on tumor stage, liver function, and patient characteristics. Treatment options include surgical resection, loco-regional therapies, systemic therapy, and liver transplantation. Oncology nurses play a vital role in HCC prevention and management through public education, patient advocacy, and support for caregivers. Strengthening nursing education, research, and interdisciplinary collaboration is essential to optimize HCC management in the Saudi Arabia.

Keywords: Hepatocellular carcinoma, HCC, nurses

Introduction

Hepatocellular carcinoma HCC ranks as the sixth most prevalent cancer globally and represents the third leading contributor to cancer-related mortality Ferlay et al., 2015; Song & Bae, 2014. Annually, over 560,000 new cases are diagnosed, reflecting a threefold increase in incidence rates over the last thirty years [3,4]. The prognosis for HCC remains exceedingly poor, with overall survival rates ranging between 3% and 5% [5]. A majority of patients experience disease progression leading to mortality within one year of diagnosis, and untreated cases have a median survival of merely five months [3,4,6]. This unfavorable prognosis is largely attributed to the asymptomatic nature of early-stage disease and the frequent identification of advanced-stage tumors at initial clinical presentation [2,7]. Consequently, HCC is distinguished by one of the highest mortality-to-incidence ratios among malignancies worldwide Zhu et al., 2016.

HCC is unique among cancers due to its well-defined etiological associations in most cases Carr et al., 2015. Chronic hepatitis B virus HBV infection constitutes the primary risk factor, accounting for over 75% of global HCC diagnoses [10–12]. Hepatitis C virus HCV infection, though less prevalent, also contributes significantly. Additional risk modifiers include chronic liver diseases exacerbated by alcohol-induced cirrhosis, metabolic disorders such as obesity and type 2 diabetes, environmental exposures to dietary aflatoxins, and tobacco use. Demographic factors, including advanced age and male sex, further elevate susceptibility.

Pathogenesis

Hepatocellular carcinoma HCC primarily arises from hepatocytes, with approximately 70%–90% of cases developing in individuals with preexisting cirrhosis. In cases associated with chronic hepatitis B virus HBV infection, the virus contributes to hepatocarcinogenesis by inducing genomic alterations within chromosomal DNA, ultimately leading to metaplastic changes in hepatocytes Kar, 2014. Histopathological analysis frequently reveals the presence of HBV DNA integrated into the genome of both infected hepatocytes and malignant hepatic cells [3]. It is hypothesized that HBV exerts its oncogenic potential by integrating its viral DNA into or near key proto-oncogenes and tumor suppressor genes, disrupting normal cellular regulatory mechanisms and promoting malignant transformation over an extended period. This repetitive cycle of hepatocyte damage and aberrant regeneration, often spanning 25–30 years following initial HBV infection, significantly increases the likelihood of HCC development [3, 15].

Unlike HBV-related HCC, the pathogenesis of HCC in hepatitis C virus HCV infections does not involve direct viral DNA integration into the host genome. Instead, HCV is an RNA virus that establishes persistent infection through continuous replication, resulting in chronic liver inflammation and immune dysregulation [7, 16]. The persistent inflammatory environment associated with HCV infection contributes to progressive hepatocellular damage, fibrosis, and ultimately cirrhosis, which serves as a precursor to malignant transformation. The mechanism of HCV-induced carcinogenesis is multifaceted, involving oxidative stress, altered cell signaling pathways, and immune evasion strategies that facilitate uncontrolled cellular proliferation [7, 16]. Over time, persistent hepatocyte injury and fibrosis lead to decompensated liver function, characterized by a structurally distorted, cirrhotic liver architecture, significantly increasing the risk of HCC development in affected individuals [17].

Additionally, both HBV and HCV infections contribute to HCC progression through the activation of oncogenic pathways and suppression of tumor suppressor functions. Chronic HBV infection has been associated with alterations in Wnt/β-catenin signaling, which plays a pivotal role in hepatocyte proliferation and differentiation. Similarly, HCV proteins have been shown to modulate key cellular pathways, including the Janus kinase/signal transducer and activator of transcription JAK/STAT pathway, the mitogen-activated protein kinase MAPK pathway, and nuclear factor-kappa B NF-κB signaling, all of which promote hepatic inflammation, fibrosis, and carcinogenesis

Borzio et al., 2015. Furthermore, viral infections may contribute to epigenetic modifications such as DNA methylation and histone acetylation, which can further disrupt normal gene expression patterns and facilitate malignant transformation Ashtari et al., 2015.

Beyond viral infections, additional molecular mechanisms play a role in the pathogenesis of HCC, particularly in the context of non-viral etiologies. In cases where HCC arises from metabolic dysfunction-associated fatty liver disease MAFLD or alcohol-related liver disease, key drivers of carcinogenesis include chronic oxidative stress, lipid peroxidation, and alterations in insulin-like growth factor IGF signaling. These factors contribute to hepatocyte injury, fibrosis, and genetic instability, ultimately promoting hepatocellular malignant transformation. The interplay between genetic predisposition, environmental factors, and chronic hepatic injury underscores the complexity of HCC pathogenesis and highlights the necessity for targeted preventive and therapeutic strategies to mitigate disease progression [7, 17].

Risk Factors

Hepatitis B Virus HBV

Hepatitis B virus HBV is a highly infectious pathogen primarily transmitted from mother to child during childbirth, a process known as vertical transmission Center & Jemal, 2011. Individuals who become chronic carriers of HBV are often infected during early childhood, though horizontal transmission, particularly through unprotected sexual contact, is also a well-documented route of infection [4]. Epidemiological data indicate that approximately 5% of the global population is chronically infected with HBV, and the virus is implicated in 50%–80% of hepatocellular carcinoma HCC cases worldwide [7, 8].

Beyond vertical and sexual transmission, percutaneous exposure to infected blood, such as through unsafe medical practices, needle-sharing among people who inject drugs, and inadequately sterilized tattooing equipment, also contributes to HBV transmission. Additionally, co-infections with other hepatotropic viruses, such as hepatitis C virus HCV and human immunodeficiency virus HIV, may accelerate liver disease progression in HBV carriers, further increasing their risk of developing HCC [6, 7].

Hepatitis C Virus HCV

Hepatitis C virus HCV infection is significantly less prevalent than HBV, affecting approximately one-third of the number of individuals infected with HBV globally. Unlike HBV, HCV transmission typically occurs in adulthood and is most frequently associated with exposure to contaminated needles, injection drug use, and procedures involving unscreened blood transfusions [4]. High-risk populations for HCV include individuals undergoing hemodialysis, recipients of blood products prior to the introduction of routine blood screening in 1990, and those engaging in practices such as body piercing and tattooing with unsterilized equipment [7].

HCV-related HCC development is largely attributed to chronic liver inflammation and fibrosis, which lead to cirrhosis and eventual malignant transformation of hepatocytes [7, 16]. In addition to viral exposure, several host and environmental factors are known to exacerbate the risk of HCC in individuals with HCV infection. These include metabolic conditions such as obesity and type 2 diabetes, prolonged alcohol consumption, and co-infection with HBV or HIV [4, 6]. The rising global prevalence of metabolic dysfunction-associated fatty liver disease MAFLD has also been recognized as a compounding factor in HCV-induced liver disease progression, further increasing the risk of HCC [7].

Cirrhosis and Alcohol Consumption

Cirrhosis is one of the most significant risk factors for HCC, with 70%–90% of HBV-related HCC cases occurring in cirrhotic livers [1, 8]. The fibrotic remodeling of hepatic architecture in cirrhosis fosters a microenvironment conducive to carcinogenesis by promoting chronic inflammation, oxidative stress, and genomic instability. While cirrhosis can arise from a variety of causes, excessive alcohol consumption remains a major contributor to liver damage and subsequent HCC development.

Studies have demonstrated that chronic heavy alcohol intake—defined as more than 50–70 grams per day—does not directly induce carcinogenesis but rather accelerates the progression of cirrhosis, which is a well-established precursor to HCC [7, 10, 21]. Alcohol is therefore regarded as a co-carcinogen, as it exacerbates hepatic inflammation, impairs immune surveillance, and enhances the activation of carcinogenic pathways [6]. Furthermore, individuals who consume excessive alcohol while being chronically infected with HBV or HCV are at an even greater risk of developing HCC, as alcohol-induced hepatotoxicity compounds the detrimental effects of viral hepatitis on liver health.

Aflatoxin B1 Exposure

Aflatoxins are highly potent hepatocarcinogenic mycotoxins produced by fungi, particularly *Aspergillus flavus* and *Aspergillus parasiticus*. These toxins frequently contaminate crops such as grains, corn, peanuts, and soybeans, especially in regions with warm and humid climates [7, 8, 10]. Chronic dietary exposure to aflatoxin B1 has been linked to hepatocarcinogenesis, primarily through its ability to induce genetic mutations in tumor suppressor genes, particularly *p53* [10]. In fact, mutations in the *p53* gene are observed in 30%–60% of all HCC cases, highlighting the significant role of aflatoxin exposure in liver cancer development [10].

Furthermore, the carcinogenic potential of aflatoxins is believed to be synergistic with HBV infection, meaning that individuals who are both HBV carriers and regularly exposed to aflatoxin-contaminated food are at an exponentially higher risk of developing HCC compared to those with either risk factor alone. This underscores the need for public health interventions aimed at reducing aflatoxin exposure, including improved agricultural storage methods, food safety regulations, and dietary diversification to minimize reliance on high-risk staple crops [8].

Advanced Age

Age is another critical determinant of HCC risk, with incidence rates rising sharply after the age of 40 [6, 8]. Individuals over the age of 75 face a 14-fold increased risk of developing HCC compared to younger adults [3, 8]. This elevated risk is attributed to the cumulative effects of prolonged exposure to risk factors such as chronic HBV and HCV infections, metabolic syndrome, and environmental carcinogens. Additionally, the physiological aging process contributes to the gradual decline of hepatic regenerative capacity, making aged livers more susceptible to malignant transformation following decades of chronic liver injury.

As global life expectancy continues to rise, the burden of HCC is expected to increase correspondingly, particularly in populations with high rates of chronic hepatitis infections and cirrhosis [22, 23]. The growing number of elderly individuals living with undiagnosed or untreated liver disease emphasizes the importance of age-targeted screening programs and early intervention strategies aimed at preventing HCC in at-risk populations.

Moreover, research suggests that aging is associated with epigenetic changes and alterations in immune surveillance, both of which may further contribute to the development and progression of HCC. Inflammatory processes that accumulate over time, including chronic activation of pro-inflammatory cytokines, oxidative stress, and DNA damage, may create an oncogenic hepatic environment in older adults. These findings reinforce the need for comprehensive liver health monitoring in aging populations to mitigate the increasing incidence of HCC in the coming years [6, 8, 22].

Male Gender as a Risk Factor

The incidence of hepatocellular carcinoma HCC is significantly higher in males, with studies indicating that men have nearly three times the risk of developing HCC compared to women [6, 7, 8]. This disparity is particularly pronounced in certain regions, such as Korea, Indonesia, and Vietnam, where men are four times more likely to develop HCC than women. The underlying cause of this gender-based difference is thought to be multifactorial, with lifestyle and environmental exposures playing a crucial role. Specifically, men have higher rates of alcohol

consumption, tobacco use, and obesity—each of which independently contributes to an increased risk of HCC [7].

Additionally, hormonal influences have been suggested as a contributing factor in the observed gender disparity. Androgens and their receptors may enhance liver carcinogenesis, whereas estrogens have been postulated to exert a protective effect by modulating inflammatory and fibrotic pathways in the liver [6, 8]. However, exceptions to the typical gender-based distribution of HCC do exist. For example, among elderly Japanese populations, HCC incidence rates among women are nearly equivalent to those observed in men. This suggests that additional factors, including longevity, genetic predisposition, and regional variations in lifestyle habits, may also contribute to the risk of HCC among women [8].

Obesity and Diabetes as Risk Factors

The rising global prevalence of obesity has been increasingly recognized as a significant risk factor for HCC. Excess adiposity is strongly associated with metabolic dysfunction, which contributes to the development of non-alcoholic fatty liver disease NAFLD and its more severe form, non-alcoholic steatohepatitis NASH. NAFLD and NASH can progress to cirrhosis, thereby increasing the likelihood of HCC development [7, 14]. The interplay between obesity, insulin resistance, and chronic hepatic inflammation creates a pro-carcinogenic environment within the liver, characterized by oxidative stress, dysregulated lipid metabolism, and altered immune responses [14].

Diabetes mellitus, particularly type 2 diabetes, further compounds the risk of HCC. Epidemiological studies have demonstrated that individuals with diabetes have a two- to fourfold increased risk of developing HCC, even after adjusting for other established risk factors [10]. The mechanisms underlying this association are complex and multifaceted, involving hyperinsulinemia, increased production of insulin-like growth factor-1 IGF-1, and chronic low-grade inflammation—all of which contribute to hepatocarcinogenesis [7]. Additionally, diabetes is frequently associated with obesity, dyslipidemia, and hypertension, forming a constellation of metabolic risk factors that exacerbate liver disease progression and elevate HCC risk.

Given the increasing prevalence of obesity and diabetes in many parts of the world, it is anticipated that these metabolic disorders will play a growing role in shaping the future epidemiology of HCC. Public health initiatives targeting obesity prevention, lifestyle modifications, and diabetes management will be essential to mitigate the rising burden of HCC attributable to metabolic dysfunction.

The Impact of Co-Existing Risk Factors on HCC Development

HCC is a highly heterogeneous malignancy characterized by multiple coexisting risk factors, each contributing to its pathogenesis in a complex and interrelated manner [4]. Although chronic HBV infection remains the predominant etiology of HCC, other risk-enhancing conditions, including alcohol abuse, metabolic syndrome, and environmental exposures, must also be addressed in efforts to reduce HCC incidence [4].

The increasing burden of obesity and diabetes, coupled with persistently high rates of HBV infection, suggests that the region may continue to experience a significant rise in HCC cases. Therefore, interdisciplinary collaborations and multinational research efforts are essential to advancing knowledge about HCC prevention, early detection, and treatment strategies. Coordinated efforts involving clinicians, epidemiologists, public health professionals, and policymakers will be crucial in addressing the challenges posed by this aggressive malignancy.

Interventions for HCC Management

Despite the availability of multiple interventions to manage HCC, the prognosis for this malignancy remains poor, with limited curative treatment options available [4]. Consequently, prevention remains the most effective strategy for reducing the global burden of HCC.

Primary Prevention Strategies

The most successful approach to lowering HCC incidence is through preventive measures targeting its major risk factors [13]. Among these, HBV vaccination is the single most effective intervention

for reducing HBV-related HCC worldwide. When administered within 24 hours of birth, HBV vaccines are 70%–95% effective at preventing vertical transmission of the virus, thereby significantly reducing the likelihood of chronic HBV infection [12]. In endemic regions, widespread immunization efforts have been shown to decrease chronic HBV prevalence by up to 90% within a single generation.

Since the introduction of HBV vaccines in 1982, global immunization initiatives have expanded significantly. In 1992, only 31 countries had implemented national HBV vaccination programs, whereas by 2006, this number had increased to 164 countries [13]. Taiwan provides a notable example of the success of HBV vaccination in reducing HCC incidence, as the country observed a substantial decline in new HCC cases within a decade of introducing its nationwide immunization program.

The Working Party on Prevention of Hepatocellular Cancers has outlined several key recommendations for HCC prevention [13]:

- **Universal HBV vaccination programs should be established and maintained** in all countries where HBV is endemic.
- **Extended infant immunization schedules, including HBV vaccination, should be implemented** to ensure comprehensive coverage across diverse communities.
- **Mandatory screening of all blood products for HBV and HCV should be enforced** to prevent transmission through transfusions and medical procedures.
- **Healthcare institutions should adopt strict infection control protocols**, including:
    - The use of disposable needles, syringes, and medical devices that come into contact with blood.
    - Rigorous sterilization of endoscopic and surgical equipment.
    - Universal gloving and protective measures for healthcare workers handling blood products.
    - The avoidance of multiple-use vials for injectable medications.
    - Preventing transmission from viremic healthcare workers to patients [13].

Addressing Other Modifiable Risk Factors

Beyond HBV vaccination, additional public health measures are necessary to mitigate other modifiable risk factors associated with HCC. The Working Party has emphasized the importance of ensuring access to clean drinking water, as contaminated water sources can contribute to the spread of infectious diseases, including viral hepatitis [13].

Efforts to reduce dietary exposure to aflatoxins are also critical. The adoption of improved agricultural storage methods, including refrigeration and stringent food safety protocols, can help prevent fungal contamination of staple crops such as grains, peanuts, and soybeans. These measures are particularly important in regions where aflatoxin exposure remains a major contributor to HCC incidence [10].

Furthermore, targeted interventions addressing obesity, diabetes, and alcohol consumption are needed to counteract the metabolic and lifestyle-related risk factors driving HCC prevalence. Public health campaigns promoting healthy dietary habits, physical activity, and responsible alcohol consumption can help reduce the burden of metabolic liver diseases and, in turn, lower the risk of HCC.

As global HCC incidence continues to rise, a comprehensive, multi-faceted approach encompassing vaccination, infection control, lifestyle interventions, and regulatory measures will be essential in curbing the impact of this devastating malignancy.

Surveillance and Screening for Early Detection of Hepatocellular Carcinoma HCC

There are various strategies to optimize early detection surveillance programs for HCC. To illustrate, consider a hypothetical high-risk patient based on well-established risk factors. This individual is likely to be an older male who is overweight, has a history of type 2 diabetes, and has

been diagnosed with chronic hepatitis B virus HBV infection along with cirrhosis. Additionally, he consumes alcohol heavily and resides in a rural region of Korea or Vietnam, where access to healthcare services may be limited. Implementing an effective early screening protocol for such a high-risk individual would necessitate the use of a validated blood biomarker assay, imaging techniques with high sensitivity for detecting small hepatic lesions, a structured approach to risk communication, and mechanisms to ensure adherence to recommended screening schedules.

Currently, the standard methods for HCC screening involve the use of hepatic ultrasonography in conjunction with serum alpha-fetoprotein AFP testing. These modalities are specifically recommended for individuals with known cirrhosis, given their heightened risk of developing HCC Torre et al., 2015. Screening at regular intervals—typically every six months—is advised to enhance the likelihood of detecting tumors at an early and potentially curable stage [4, 12]. Japan has recently reported significant improvements in overall survival rates among HCC patients, largely attributable to the implementation of a comprehensive nationwide surveillance program. This underscores the potential benefits of adopting similarly intensive screening initiatives in other countries, particularly those with a high burden of HCC. Strengthening national surveillance programs through improved access to diagnostic tools, better patient education, and integration of risk stratification models may help replicate Japan's success in reducing HCC-related mortality.

While ultrasonography and AFP testing remain the cornerstone of HCC surveillance, ongoing research is investigating alternative biomarkers and imaging modalities that may further enhance early detection. Emerging evidence suggests that liquid biopsy techniques, incorporating circulating tumor DNA ctDNA and other molecular markers, may offer improved specificity and sensitivity over current screening methods. Additionally, advancements in artificial intelligence AI-driven image analysis could facilitate more accurate interpretation of ultrasound and cross-sectional imaging results, thereby reducing operator dependence and improving diagnostic consistency. Future research should focus on validating these novel approaches and integrating them into existing surveillance frameworks, particularly in resource-limited settings where access to high-quality imaging may be restricted.

Management of Hepatocellular Carcinoma

Due to its complex and heterogeneous nature, HCC necessitates an individualized treatment approach tailored to the tumor stage, liver function status, and patient-specific characteristics. Multiple international guidelines have been developed to guide the staging and management of HCC; however, their applicability varies across different regions due to disparities in resource availability, technological infrastructure, and clinical expertise Yu, 2016. A comprehensive review conducted by Yu [25], Fong, and Tanabe [4] compared existing guidelines and highlighted the need for context-specific adaptations.

Accurate assessment of tumor extent is a critical determinant of treatment selection Raza & Sood, 2014. Broadly, there are four main therapeutic strategies for HCC, each of which is dependent on the stage of the disease. These options include surgical resection, loco-regional therapies, systemic therapy, and liver transplantation. The eligibility criteria for each treatment modality are outlined in Table 1, which delineates key factors such as tumor size, number of hepatic lesions, degree of vascular invasion, and presence of regional lymph node involvement or distant metastases [4, 12, 25].

Table 1: Treatment Options for Hepatocellular Carcinoma and Patient Eligibility Criteria

Treatment Type	Eligibility Considerations
Surgical Resection	Reserved for patients without cirrhosis or portal hypertension; candidates should have a solitary hepatic lesion or fewer than three small intrahepatic tumors without macrovascular invasion.
Loco-Regional Therapy	Considered for patients who are ineligible for surgical resection but have well-preserved liver function; applicable to cases with up to three tumors ≤3 cm in size without macrovascular invasion or extrahepatic spread.
Systemic Therapy	Recommended for individuals with unresectable or advanced-stage HCC; sorafenib has demonstrated a survival benefit in clinical trials.
Liver Transplantation	Indicated for early-stage HCC, characterized by a single lesion ≤5 cm or up to three small lesions; suitable for patients with moderate-to-severe cirrhosis who are not candidates for resection.

Surgical resection is generally the preferred curative treatment for patients with localized HCC who have preserved liver function and sufficient hepatic reserve to tolerate partial hepatectomy [4, 12]. However, this option is typically not feasible for individuals with cirrhosis-related complications such as portal hypertension, ascites, or significant coagulopathy, as these factors increase the risk of postoperative hepatic decompensation and liver failure [12]. Notably, only a small subset of HCC patients present with resectable disease at the time of diagnosis. Consequently, alternative treatment modalities are frequently required to manage the majority of HCC cases.

Loco-regional therapies are employed with the goal of delaying tumor progression and reducing microvascular invasion, thereby mitigating the risk of metastasis [25]. These interventions are primarily indicated for patients with preserved hepatic function and either solitary tumors or a limited number of small hepatic lesions. Several loco-regional treatment options exist, including radiofrequency ablation RFA, percutaneous ethanol injection PEI, transarterial chemoembolization TACE, and intrahepatic arterial infusion of yttrium-90 Nishikawa et al., 2013.These techniques function by selectively targeting the arterial blood supply of the tumor, creating a hypoxic and ischemic microenvironment that promotes tumor necrosis. Importantly, loco-regional therapies serve as a bridge to transplantation in selected patients, improving disease control while awaiting donor organ availability.

For patients with advanced or metastatic HCC, systemic therapy is the standard of care. Sorafenib, an orally administered multikinase inhibitor, is the only systemic agent that has demonstrated a survival benefit in prospective clinical trials [4]. By exerting antiangiogenic and antiproliferative effects, sorafenib disrupts multiple signaling pathways implicated in tumor progression [26]. Despite its efficacy, the use of sorafenib is frequently associated with adverse effects such as diarrhea, fatigue, hand–foot skin reactions, and dermatologic toxicities, which often necessitate dose reductions or temporary treatment discontinuation [2]. Ongoing research is exploring novel systemic therapies, including immune checkpoint inhibitors and combination regimens, to improve treatment outcomes for patients with advanced HCC.

As hepatocellular carcinoma HCC continues to be recognized as a highly aggressive malignancy with limited curative treatment options, significant research efforts have been directed toward the development of novel immunotherapy approaches. One of the primary challenges in HCC treatment is the immune system's inability to effectively detect and eliminate malignant hepatocytes. This has led to a growing interest in immunotherapeutic strategies aimed at enhancing the immune response against hepatic tumors. Specifically, targeted therapies such as immune checkpoint inhibitors, which modulate immune evasion mechanisms, have gained considerable attention. When administered in conjunction with established treatment modalities such as surgical

resection and loco-regional interventions, these immunotherapies are anticipated to shape the next phase of treatment advancements for patients with HCC Raufi & Tirona, 2017.

Despite the strong association between advanced age and increased risk for HCC, elderly patients remain significantly underrepresented in clinical trials investigating novel therapeutic agents for this malignancy [22]. This exclusion has direct implications for the formulation of evidence-based treatment recommendations, as a discrepancy exists between clinical practice realities and the interventional guidelines derived from trials predominantly conducted in younger populations [16]. To bridge this gap, dedicated clinical trials targeting older adults with HCC are urgently required. These trials must be designed to account for age-related comorbidities and potential drug toxicities, as safety considerations are a crucial component of treatment decision-making for this population [16, 22, 23]. The establishment of age-specific research initiatives could lead to more tailored therapeutic strategies that optimize both efficacy and tolerability in elderly patients.

Another significant challenge in the management of HCC is the financial burden associated with systemic therapy. Sorafenib, the first-line systemic treatment for advanced HCC, is prohibitively expensive, costing approximately $5400 USD per month. This cost renders the drug inaccessible to many patients in low- and middle-income countries, particularly given its use in a predominantly palliative context [4]. The economic constraints associated with sorafenib underscore the urgent need for more affordable and accessible therapeutic options. One promising avenue involves the utilization of direct-acting antiviral agents for the treatment of hepatitis C virus HCV infection. These agents have demonstrated potential not only in eradicating HCV but also in improving hepatic function, halting or even reversing fibrosis and cirrhosis, and ultimately reducing the risk of HCC development Wirth & Manns, 2016. The widespread adoption of these antiviral agents could represent a paradigm shift in the prevention and management of HCC, particularly in regions with a high burden of HCV-related liver disease.

Liver transplantation remains a viable treatment option for a select subset of patients with HCC. Candidates for transplantation must meet specific eligibility criteria, including good overall performance status, a limited tumor burden, and stable disease during the waiting period for a donor organ. In addition to its curative potential for early-stage HCC, liver transplantation is also considered a therapeutic option for patients with acute decompensated cirrhosis, provided they meet the necessary transplant criteria [25]. However, access to liver transplantation is often limited by organ shortages and stringent eligibility requirements, which restrict its applicability to a relatively small proportion of HCC patients. Efforts to expand donor availability and refine transplant eligibility criteria could improve the accessibility of this treatment modality for a greater number of patients.

Until comprehensive global screening initiatives are fully operational and the early detection of HCC is significantly improved, the role of oncology nurses will primarily center on the care of patients with advanced disease. Given the poor prognosis associated with late-stage HCC, oncology nursing interventions should prioritize symptom management, quality of life enhancement, and supportive care measures tailored to both patients and their caregivers.

The Role of Oncology Nurses in HCC Prevention and Management

Oncology nurses in Saudi Arabia have a unique opportunity to influence both the prevention and management of HCC. These contributions would be most effectively facilitated through formal endorsement by national oncology nursing organizations. Such organizations could advocate for the development of official position statements, expert consensus panels, or collaborative initiatives with health ministries to promote the implementation of evidence-based nursing interventions. Within the domain of oncology nursing, two primary areas of focus include public education and patient advocacy.

One critical responsibility of oncology nurses is the provision of comprehensive public education regarding HCC prevention strategies. Public health campaigns should emphasize the importance of HBV vaccination, the risks associated with intravenous drug use, and the necessity of adhering to universal precautions to prevent viral transmission. Oncology nurses can play a direct role in

disseminating this information or collaborate with healthcare professionals and educators to deliver targeted educational initiatives. A region-wide public awareness campaign led by oncology nurses could serve as an effective strategy to heighten awareness of HCC risk factors and promote proactive prevention behaviors. Additionally, oncology nurses can engage in community outreach programs that provide educational sessions to nursing students and generalist nurses working in primary healthcare settings. This educational effort could extend to government officials and policymakers, advocating for increased financial and logistical support to facilitate outreach vaccination efforts, particularly in remote and underserved regions.

Beyond education, oncology nurses in clinical settings play a pivotal advocacy role in the care of HCC patients. In particular, they can champion the early integration of palliative care services, which is critical for improving symptom control and overall well-being in patients with advanced disease. Effective palliative care interventions address a range of distressing symptoms, including pain, fatigue, anorexia, and gastrointestinal complications, all of which significantly impact patients' quality of life. By advocating for timely palliative care referrals, oncology nurses can ensure that patients receive appropriate symptom management and psychosocial support from the onset of their diagnosis [4, 12].

Additionally, oncology nurses serve as key sources of guidance and support for family caregivers, who often assume the primary responsibility for at-home patient care. As HCC progresses, increasing functional decline and symptom burden necessitate greater caregiver involvement. Oncology nurses should provide caregivers with detailed instructions on managing their loved one’s care, addressing common challenges such as nutrition, mobility assistance, and medication administration. Moreover, emotional and psychological support for caregivers is essential, as the demands of providing long-term care can be physically and emotionally exhausting. Given that many caregivers reside at a distance from specialized oncology teams, equipping them with telehealth resources and remote consultation options may enhance their ability to manage care responsibilities effectively.

Overall, oncology nurses play a vital role in shaping both the prevention and treatment landscape for HCC. Through targeted public health education initiatives, they can contribute to reducing disease incidence by promoting vaccination and risk-reduction strategies. In clinical settings, their advocacy for early palliative care integration and caregiver support is instrumental in enhancing the quality of life for patients with advanced HCC. Future efforts should focus on strengthening nursing education programs, expanding research on nursing-led interventions, and fostering interdisciplinary collaboration to optimize HCC management.

Conclusion

Hepatocellular carcinoma HCC remains a significant global health burden, with its rising incidence and poor prognosis necessitating a multidisciplinary approach to prevention, early detection, and treatment. Despite advancements in therapeutic interventions, including surgical resection, loco-regional therapies, systemic treatments, and liver transplantation, HCC continues to pose substantial challenges due to late-stage diagnoses, limited treatment accessibility, and high recurrence rates. The integration of immunotherapy, targeted therapies, and antiviral agents presents a promising future for improving survival outcomes, yet barriers such as cost and accessibility must be addressed, particularly in low-resource settings.

Oncology nurses play an essential role in both the prevention and management of HCC where the disease burden is highest. Their contributions extend beyond clinical care to include public health education, patient advocacy, and palliative support for those with advanced disease. Through vaccination initiatives, risk awareness campaigns, and early palliative interventions, oncology nurses can significantly impact the quality of life and overall outcomes for HCC patients. Moving forward, increased efforts in research, policy advocacy, and resource allocation will be necessary to optimize HCC care, reduce incidence rates, and improve patient survival.

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