International Journal of Research and Review
[Indexed, Peer-Reviewed Journal]
Volume 12; Issue: 7; July 2025
Website: www.ijrrjournal.com
Review Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Transforming Chronic Hepatitis C Treatment with Innovation, Efficacy and Challenges

Tadikonda Rama Rao[1], Sunkoju Vanisri[2]

[1]Professor and Principal, CMR College of Pharmacy, Hyderabad, Telangana, India
[2]Department of Pharmaceutical Analysis, CMR College of Pharmacy, Hyderabad, Telangana, India

Corresponding Author: Tadikonda Rama Rao

DOI: https://doi.org/10.52403/ijrr.20250752

ABSTRACT

One of the main causes of liver disorders, such as Cirrhosis and Hepatocellular Carcinoma, is the hepatitis C virus (HCV). Roughly 3% of people worldwide have HCV infection. HCV infection is therefore seen as a public health concern. It is important to note that the prevalence of HCV varies by country, with high endemic countries having infection rates of about 20%. An estimated 170 million individuals have a chronic HCV infection. In many nations, end-stage liver disease linked to HCV is the primary reason for liver transplantation. The tendency of HCV infection to be chronic is one of its characteristics. Due to the large degree of genetic diversity, HCV can evade the host's immunological response. Liver lesions are mostly associated with immune-mediated mechanisms, which are typified by a preponderance of type 1 helper cell response, and HCV is not directly cytopathic. Although little is known about the co-factors that affect the disease's outcome, such as age, gender, and alcohol use, other factors, like immunologic and genetic factors, might be crucial. Thus, the term "silent disease" refers to hepatitis C. During infection, neutralizing antibodies are generated against a number of HCV proteins; yet, the virus mutates to evade these antibodies. Fatigue, muscle pains, nausea, and discomfort are some of the symptoms that some individuals with chronic hepatitis C may experience. Chronic HCV infection has also been linked to immune-complex-mediated and autoimmune disorders.

KEY WORDS: Hepatitis C virus, Liver disorders, Cirrhosis, Hepatocellular carcinoma

INTRODUCTION

WHAT IS HEPATITIS C?

The Flaviviridae family includes the blood-borne disease known as the hepatitis C virus (HCV). When liver cells are infected by this single-stranded, positive-sense RNA virus, a variety of liver disorders can develop, ranging from mild inflammation to more serious conditions including cirrhosis and hepatocellular carcinoma. The virus is well-known for having a high degree of genetic diversity, which helps it avoid detection by the host immune system and makes it chronic[1]. Millions of people worldwide suffer from chronic liver disease, which is largely caused by HCV. The main method of HCV transmission is blood-to-blood contact, and typical pathways include non-sterile medical equipment, hazardous injection techniques, and unscreened blood transfusions[2].

Hepatitis C can be acute or chronic:

Hepatitis C acute

Acute hepatitis C infection is rarely identified, as most acutely infected persons exhibit no symptoms. Seventy to eighty percent of individuals were asymptomatic in the transfusion scenario, where abrupt onset of HCV infection has been most characterized. 14 Clinical signs may appear in 20% to 30% of persons with an acute HCV infection. Three to twelve weeks following exposure is when symptoms first appear.[3,4]

Hepatitis C chronic

Without therapy, the majority of patients (about 80%) are unable to fend off the illness. You will have chronic hepatitis C in this situation. Your liver becomes inflamed due to a hepatitis C infection, which ultimately results in damage and irreversible scarring (cirrhosis). Liver cirrhosis is a dangerous illness that can worsen over time.

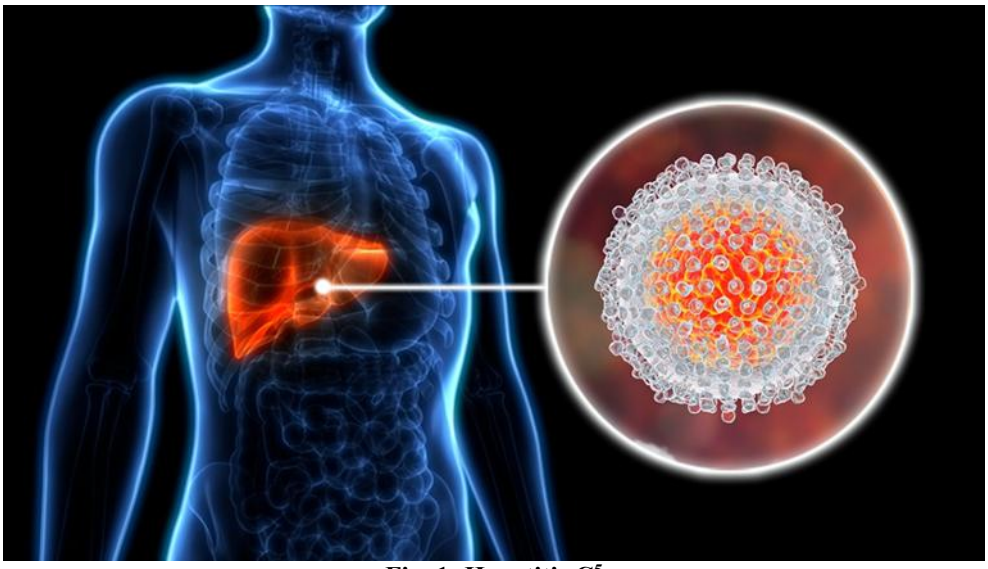

Fig. 1: Hepatitis C[5]

TRANSMISSION

Research has shown that blood-to-blood contact is the main way that the hepatitis C virus (HCV) is spread. Sharing needles among drug injectors is one example of an unsafe injection practice that continues to be a major global concern. Blood transfusions without screening remain a serious concern in areas with inadequate healthcare infrastructure. Historically, the spread of HCV has been facilitated by the reuse of non-sterile medical equipment, especially in low-income nations[6]. Another known pathway, however less frequent, is mother-to-child transfer during childbirth[7].

INCUBATION PERIOD

The majority of hepatitis C patients show no symptoms. Only one-third of individuals experience symptoms and icteric infection, which has an incubation period of 7 weeks (range: 4–20 weeks).[8]

SYMPTOMS

Jaundice, exhaustion, gray stools, weakness, anorexia, itchy skin, and black urine are some of the symptoms. Mild cognitive Fatigue and issues are the main signs of chronic hepatitis C[9]. The signs of HCV, such as a history of lethargy, diarrhea, and abdominal pains, were demonstrated in an Egyptian investigation. An additional investigation was conducted on 77 Spanish and Italian kids showed that, on average, they had no symptoms of HCV[10]. Arthralgias, Paresthesias, Myalgias, Pruritus, Sicca syndrome, Sensory neuropathy Synthetic dysfunction and portal hypertension are linked to symptoms that are typical of consequences from severe or

decompensated liver disease, including the following:
Changes in mental state (hepatic encephalopathy), Abdominal distention (ascites) with ankle edema, Variceal hemorrhage, also known as melena or hematemesis.

The Prodromal Phase:
A number of people experience symptoms such as fever, arthralgia, arthritis, rashes, and angioneurotic edema prior to the appropriate onset of the disease. Jaundice, the most prevalent and odd symptom of HCV, is the last of these symptoms[11].

HCV infection and genotype frequency
While HCV-1, HCV-2, and HCV-3 are found all over the world, HCV-4, HCV-5, and HCV-6 are only found in specific regions. Few people have the highest frequency of HCV nations and regions, like those in Europe. There are 25 million HCV-positive cases[12]. HCV is 5% common in Pakistan[13], in contrast, the Khyber Pakhtunkhwa province of Pakistan has a 5–9% incidence[14] resulting in liver cancer[15]. More than 80% of HCV infections are caused by HCV-4, which is common in the Middle East and Africa and has lately expanded to other nations in Europe. Egypt has the highest frequency of HCV-4, which causes about 90% of infections and is a leading cause of liver cirrhosis, chronic hepatitis, hepatocellular cancer, and transplantation, as well as the highest incidence of HCV worldwide (15%). While approximately 20% of the 170 million cases of hepatitis C worldwide are caused by HCV-4[16].
The number of new HCV virus cases in the US has decreased from a record of 200,000 per year to roughly 17,000 in 2007. Up to 85% of newly infected individuals developed a persistent infection after failing to eradicate the virus. Infection with HCV is a risk factor for liver cancer and the primary cause of liver transplants in the United States[17]. The majority of HCV infections worldwide are caused by the globally distributed genotypes 1a (HCV-1a), 1b, 2a, 2b, and 3a. The most prevalent genotype in the world, HCV-1b, is also the most prevalent in Asia-Pacific, especially in China, Taiwan, South Korea, and Japan. Additionally, HCV-2a and 2b are widely dispersed, especially in Japan. Taiwan's southern region and South Korea[18,19,20]. In Australia, New Zealand, Southeast Asia, and the Indian subcontinent, HCV-3 is extremely common[21,22]. According to recent data, HCV-3a is currently the most common genotype in individuals who take intravenous drugs (IDUs), and its prevalence is spreading around the world[23]. HCV-6 was primarily found in South-East Asia[24], while HCV-5 was restricted to South Africa14[25].
In South-East Asia, genotypes 7 to 11 have recently been discovered; they have been reclassified as subtypes of genotypes 3 and 6 and seem to represent the variants of HCV-3 (genotype 10a) and HCV-6a (genotypes 7, 8, 9, 11)[19]. The 5′ untranslated region (5′UTR) of the viral genome is the most often used target region for genotyping. A drawback of the approach is that, due to their close nucleotide similarity in the 5′UTR, HCV-6c-1, which is very common in the Asia-Pacific area, may be mistakenly classified as HCV-1b[26]. The formation of HCC and the progression of the disease have been linked to HCV-1b1[18,27,28]. However, there is still debate regarding whether HCV genotypes are inherently harmful. Because chronic HCV-3 infection inhibits lipoprotein production during viral replication, it is linked to cytopathic steatosis[29], whereas insulin resistance brought on by the virus is the main cause of metabolic steatosis in patients who are not infected with HCV-3[30].

DIAGNOSIS
Both direct and indirect approaches were used to diagnose HCV infection. Indirect techniques were used to measure secretions against Hepatitis viruses using antibodies such Anti-HCV IgM for current infections and Anti-HCV IgG for older infections.

Viral antigens were isolated and identified using nucleoid acid in the direct technique. In general, to confirm HCV infection, recombinant immunoblot assays and fast immunoassay tests were employed for screening. Anti-HCV antibody detection was the primary method used to diagnose HCV infection. One to two weeks following HCV exposure, HCV-RNA can identify infection, and the test is positive in patients with at least 50 international units of HCV. Within two to eight weeks following exposure, serum levels of Alanine Transferase rose and reached up to ten times the usual level[9]. Laboratory tests were employed to diagnose and monitor patients for HCV infection.

HCV antibodies were found using serologic testing, while HCV-RNA was found and evaluated using molecular testing[31]. Only high-risk patients need to be screened; screening of the general population was not advised for everyone[32]. HCV screening is advised by the American Association for the Study of Liver Disease (AASLD) for certain populations, including those who have received blood or blood products, abuse IV drugs, require dialysis, have thalassemic or hemophilic conditions, or have abnormal liver enzymes, babies born to moms infected with HCV, and needlestick injuries among healthcare professionals[33]. Enzyme immunoassay (EIA) for anti-HCV immunoglobulin was a serologic assay that was used for 30 to 90 days after HCV admission. The first generation of EIA had 80% sensitivity, while the second generation had 95% sensitivity. An unstructured protein (NS5) was detected in the third generation of assays, which exhibited a sensitivity of around 97% when added to second-generation antigens[34]. The liver status is evaluated using aspartate aminotransferase (AST) and alanine aminotransferase (ALT).

Cirrhosis can be indicated by a decrease in the platelet and ALT/AST ratio as well as a prolonged prothrombin time (PT). Individuals with chronic HCV, liver cirrhosis, and fibrosis must application to hepatocellular carcinoma. Patients who are suspected of having an HCV infection need to be evaluated using sensitive tests for HCV-RNA and anti-HCV EIA antibodies. HCV-RNA was found in patients with acute Hepatitis C who did not have anti-HCV antibodies. Both direct and indirect techniques, such as molecular and serologic testing, are used to diagnose HCV infection. According to AASLD guidelines, screening is directed at high-risk groups employing instruments such as enzyme immunoassays with increasing sensitivity over time, recombinant immunoblot tests, and HCV-RNA detection. For the purpose of evaluating liver health and identifying problems like cirrhosis or hepatocellular cancer, it is essential to monitor liver enzyme levels (ALT, AST). Effective care, especially in situations of acute and persistent infections, depends on early and sensitive detection. These initiatives enhance patient outcomes and reduce long-term health hazards.

Riba, or Recombinant Immunoblot Assay:

This test is used to confirm a particular serological test and can identify viral antigens.

Polymerase chain reaction (PCR):

HCV RNA can be found in patient serum or plasma using a variety of molecular methods, including real-time PCR, reverse transcriptase PCR, transcription mediated amplification (TMA), and branching DNA. When virus numbers were low, this diagnostic approach was more effective. Trugene 5/NC and the 5~ noncoding sequence are used to determine the HCV genotype, which is helpful in predicting the patient's prognosis[35].

Liver biopsy and fibroscan:

This diagnostic technique was used to evaluate cirrhosis and inflammation, and it was graded and scored using the ISHK and METAVIR, respectively, and the histological activity index (HAI). Even

while liver biopsy combined with histological evaluation was the gold standard for determining the presence of hepatic fibrosis, it has shown to be an intrusive and uncomfortable procedure for patients, and in rare instances, it may result in bleeding and incorrect diagnosis. Liver biopsies have taken the place of new noninvasive techniques that measure liver stiffness. Fibroscan, which measures liver stiffness in a single cylinder that is 4 cm long and 1 cm broad and is displayed from F0 to F4 using kpa, is one of these techniques. It uses an ultrasonic probe that operates at 5 MHZ power. Fibroscan sensitivity in F2 and F3 was higher than that of serological testing. The METAVIR grading method identifies five stages in a liver biopsy: F0 indicates no fibrosis, F1 indicates fibrosis surrounding the port, F2 indicates fibrosis of the port and port septum, F3 indicates fibrosis of the port with lobular twist, and F4 indicates hepatic cirrhosis[36].

PATHOGENESIS

HCV attacks the immune system and infected hepatocytes, causing cellular inflammation and necrosis, fibrosis, and ultimately hepatocellular cancer, although it is unable to directly enter the host cell's DNA. The advancement of hepatic fibrosis is faster in people who have both HIV and Hepatitis C co-infection independently. HCV disrupts interferon signaling pathways and defensive mechanisms. Chronic Hepatitis C is brought on by HCV, which also supplies antigen to the MCH-1 cell type. Core proteins can stop apoptosis, but nonstructural protein NS5 can disrupt cellular regularity[37].

TREATMENT

As soon as feasible, everyone with a proven chronic HCV infection should be given access to excellent care. In order to stop the development of cirrhosis, alcohol use must be monitored and controlled concurrently[38,39]. According to the modeling, treating HCV disease early on in its progression for all or certain groups may stop the disease's progression and subsequent spread[40,41,42]. Actually, not everyone who has a persistent HCV infection will develop fibrosis[43]. Therefore, a nation's medical authorities should determine when to begin anti-HCV treatment. It is important to note that cases of transmission have been reported in newly treated individuals who did not have access to preventative interventions[44]. Ribavirin and pegylated interferon alpha are used together in this treatment[45].

Cure rates for genotypes 2 and 3 were approximately 70% and 80%, respectively, while cure rates for other genotypes ranged from 45 to 70%[46]. In order to regulate genotype 1, telaprevir or boceprevir in conjunction with pegylated interferon-alpha and ribavirin is very advantageous[47]. When HCV is treated within the first six months, it works better than when it becomes chronic. If a person contracts a new infection and it persists for eight to twelve weeks without treatment, to suppress the virus, pegylated interferon is highly advised for duration of 24 weeks[48]. To manage disorders linked to HCV genotypes 1, 4, 5, or 6, a combination of sofosbuvir, ribavirin, and interferon is administered. This was 90% successful in combating viral illnesses[49]. Pegylated-interferon, simeprevir (SMV), and ribavirin (RBV) triple combination therapy was utilized in Japan in December 2013 to treat this illness, specifically genotype 1 in clinical work[50].

Timely care, early treatment, and alcohol control are essential in managing chronic HCV infections to prevent complications. National authorities must guide treatment timing, and preventive measures are crucial to reducing transmission risks.

PREVENTION

Even while only a small percentage of patients are treated in the early stages, the virus will eventually become uncontrollable and may even kill people. Inadequate vaccination and antiviral medications are accessible to manage 100% HCV.

Preventive measures, such as safe injection procedures in hospitals and other locations, secure blood supplies, and education for injectable drug abusers and intravenous drug users regarding the risk of HCV, should be our first priority. To reduce the incidence of HCV, health education is essential. To educate the public about the disease's risk factors, transmission, and prevention, special initiatives should be started.

For an early diagnosis of HCV, safe blood tests and further laboratory procedures are required[51].

HEPATITIS C VIRUS (HCV) VACCINES

1. Hepatitis C Virus DNA Vaccines:

A systematic review highlights the potential of DNA-based immunization to generate both cellular and humoral immune responses. Strategies like incorporating multiple viral proteins, molecular tags, and adjuvants have shown promise[52].

CONCLUSION

The hepatitis C virus is a major cause of liver-related disease and mortality, impacting millions of people worldwide. A leading cause of liver disease globally, chronic HCV infections can result in consequences such cirrhosis and hepatocellular cancer. With cure rates surpassing 90%, the development of Direct-Acting Antivirals (DAAs) has significantly improved treatment outcomes; yet, there are still issues with guaranteeing fair access, particularly in settings with limited resources. Many infections remain undetected, which emphasizes the importance of effective screening and education initiatives. An additional crucial area of concern is prevention. DNA-based, is the promising approach being used in the ongoing research on HCV vaccine. Initiatives to reduce harm, such safe injection techniques and education for vulnerable groups, are also essential. Promoting prevention and care equally requires addressing the stigma attached to the illness. The global burden of HCV can be considerably decreased by implementing comprehensive public health initiatives that combine prevention, early diagnosis, and efficient treatment.

Declaration by Authors

Ethical Approval: Not Applicable
Acknowledgement: None
Source of Funding: None
Conflict of Interest: No conflicts of interest declared.

REFERENCES

1. Butt, F., Shahid, M., Hassan, M. et al. A review on hepatitis C virus: role of viral and host-cellular factors in replication and existing therapeutic strategies. Egypt Liver Journal.2022; 12(71):1-8.
2. Gizamba, J.M., Finch, B.K., Wang, S. Insights into the spatial epidemiology of hepatitis C infection: systematic synthesis of area-level determinants and spatiotemporal analyses. BMC Public Health.2025; 25(687):1-13.
3. Alter H.J, Seeff L.B. Recovery, Persistence, and Sequelae in Hepatitis C Virus Infection: A Perspective on Long-Term Outcome. Seminars in Liver Disease.2000; 20(1):17–35.
4. Thimme R, Oldach D, Chang KM, Steiger C, Ray SC, Chisari FV. Determinants of Viral Clearance and Persistence during Acute Hepatitis C Virus Infection. Journal of Experimental Medicine. 2001; 194(10):1395-406.
5. Available from: https://www.cdc.gov/hepatitis-c/about/index.html
6. Stroffolini, T.; Stroffolini, G. Prevalence and Modes of Transmission of Hepatitis C Virus Infection: A Historical Worldwide Review. Viruses 2024; 16(7):1-18.
7. Miller, E.R., McNally, S., Wallace, J. et al. The ongoing impacts of hepatitis c - a systematic narrative review of the literature. BMC Public Health 12, 672 (2012), 1-13.
8. Hoofnagle JH. Hepatitis C: the clinical spectrum of disease. Hepatology. 1997, (3 Suppl 1):15S-20S. doi: 10.1002/hep.510260703. PMID: 9305658.

9. Chen SL, Morgan TR. The Natural History of Hepatitis C Virus (HCV) Infection. International Journal of Medical Sciences.2006; 3(2):47–52.
10. Jara P, Resti M, Hierro L, Giacchino R, Barbera C, Zancan L. Chronic hepatitis C virus infection in childhood: clinicalpatterns and evolution in 224 white children. Clinical Infectious Disease.2003; 36(3):275–80.
11. Tariq M, Shoukat AB, Akbar S, Hameed S, Naqvi MZ, Azher A, Saad M, Rizwan M, Nadeem M, Javed A, Ali A, Aziz S. Epidemiology, Risk Factors, And Pathogenesis Associated With A Superbug: A Comprehensive Literature Review On Hepatitis C Virus Infection. SAGE Open Med.2022; 10, 1-14.
12. Rockstroh J, Grint D, Bosecke C. Increase in acute hepatitis C virus (HCV) incidence across Europe: which region and patient groups are affected? Journal of the International AIDS Society. 2012, 15(6),1-11.
13. Afridi SQ, Zahid MN, Shabbir MZ, Hussain Z, Mukhtar N, Tipu MY. Prevalence of HCV genotypes in District Mardan. Virology Journal.2013; 10:1-4.
14. Khan N, Akmal M, Hayat M, Umar M, Ullah A, Ahmed I. Geographical Distribution Of Hepatitis C Virus Genotypes In Pakistan. Hepatitis Monthly.2014; 14(10):1-5.
15. Munaf A, Memon MS, Kumar P, Ahmed S, Kumar MB. Comparison of viral hepatitis-associated hepatocellular carcinoma due to HBV and HCV-cohort from liver clinics in Pakistan. Asian Pacific Journal of Cancer Prevention.2014; 15:7563–7567.
16. Kamal SM, Nasser IA. Hepatitis C genotype 4: What we know and what we don't yet know. Hepatology. 2008; 47(4):1371-83.
17. Rajaguru R, Nettleman MD. Hepatitis C Infection, Causes, Transmission, Symptoms, Diagnosis And Treatments: How Does Liver Damage Occur In Hepatitis C Infection?. Egyptian Journal of Medical Human Genetics.2011; 96:1127–1134.
18. Yu ML, Chuang WL, Chen SC, Dai CY, Hou C, Wang JH, Lu SN, Huang JF, Lin ZY, Hsieh MY, Tsai JF, Wang LY, Chang WY. Changing Prevalence of Hepatitis C Virus Genotypes: Molecular Epidemiology and Clinical Implications in the Hepatitis C Virus Hyperendemic Areas and a Tertiary Referral Center in Taiwan. Journal of Medical Virology. 2001; 65(1):58-65.
19. Simmonds P, Bukh J, Combet C, Deléage G, Enomoto N, Feinstone S, Halfon P, Inchauspé G, Kuiken C, Maertens G, Mizokami M, Murphy DG, Okamoto H, Pawlotsky JM, Penin F, Sablon E, Shin-I T, Stuyver LJ, Thiel HJ, Viazov S, Weiner AJ, Widell A. Consensus Proposals for A Unified System of Nomenclature of Hepatitis C Virus Genotypes. Hepatology.2005; 42(4):962-73.
20. Suh DJ, Jeong SH. Current Status of Hepatitis C Virus Infection in Korea. Intervirology. 2006; 49(1-2):70-75.
21. Valliammai T, Thyagarajan SP, Zuckerman AJ, Harrison TJ. Diversity of Genotypes of Hepatitis C Virus in Southern India. Journal of General Virology. 1995; 76 (Pt 3):711-716.
22. Nakai K, Win KM, Oo SS, Arakawa Y, Abe K. Molecular Characteristic-Based Epidemiology of Hepatitis B, C, and E Viruses and GB Virus C/Hepatitis G Virus in Myanmar. Journal of Clinical Microbiology. 2001; 39(4):1536-1539.
23. Farrell GC. New hepatitis C guidelines for the Asia-Pacific region: APASL consensus statements on the diagnosis, management and treatment of hepatitis C virus infection. Journal of Gastroenterology and Hepatology. 2007; 22(5):607-610.
24. Smuts HE, Kannemeyer J. Genotyping of Hepatitis C Virus in South Africa. Journal of Clinical Microbiology. 1995; 33(6):1679-1681.
25. Fung J, Lai CL, Hung I, Young J, Cheng C, Wong D, Yuen MF. Chronic Hepatitis C Virus Genotype 6 Infection: Response to Pegylated Interferon and Ribavirin. Journal of Infectious Diseases. 2008 Sep 15; 198(6):808-12.
26. McCaughan GW, Omata M, Amarapurkar D, Bowden S, Chow WC, Chutaputti A, Dore G, Gane E, Guan R, Hamid SS, Hardikar W, Hui CK, Jafri W, Jia JD, Lai MY, Wei L, Leung N, Piratvisuth T, Sarin S, Sollano J, Tateishi R. Asian Pacific Association For The Study of The Liver Consensus Statements On The Diagnosis, Management And Treatment Of Hepatitis C Virus Infection. Journal of Gastroenterology and Hepatology. 2007; 22(5):615-33.
27. Lee CM, Lu SN, Hung CH, Tung WC, Wang JH, Tung HD, Chen CH, Hu TH,

Changchien CS, Chen WJ. Hepatitis C Virus Genotypes in Southern Taiwan: Prevalence and Clinical Implications. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2006; 100(8):767-774.
28. Yu ML, Lin SM, Chuang WL, Dai CY, Wang JH, Lu SN, Sheen IS, Chang WY, Lee CM, Liaw YF. A Sustained Virological Response to Interferon or Interferon/Ribavirin Reduces Hepatocellular Carcinoma and Improves Survival in Chronic Hepatitis C: A Nationwide, Multicentre Study in Taiwan. Antiviral Therapy. 2006; 11(8):985-994.
29. Hui JM, Kench J, Farrell GC, Lin R, Samarasinghe D, Liddle C, Byth K, George J. Genotype-Specific Mechanisms For Hepatic Steatosis In Chronic Hepatitis C Infection. Journal of Gastroenterology and Hepatology. 2002; 17(8):873-81.
30. Sheikh MY, Choi J, Qadri I, Friedman JE, Sanyal AJ. Hepatitis C Virus Infection: Molecular Pathways to Metabolic Syndrome. Hepatology. 2008 Jun; 47(6):2127-33.
31. Pawlotsky JM. Use and Interpretation of Virological Tests for Hepatitis C. Hepatology. 2002 Nov; 36(5 Suppl 1):S65-73.
32. Recommendations for prevention and control of hepatitis C virus (HCV) infection and HCV-related chronic disease. Centers for Disease Control and Prevention. MMWR Recomm Rep. 1998; 47(RR-19): 1-39. PMID: 9790221.
33. Ghany MG, Strader DB, Thomas DL, Seeff LB; American Association for the Study of Liver Diseases. Diagnosis, Management, and Treatment of Hepatitis C: An Update. Hepatology. 2009; 49(4):1335-74.
34. Richter SS. Laboratory Assays for Diagnosis and Management of Hepatitis C Virus Infection. Journal of Clinical Microbiology. 2002; 40(12):4407-12.
35. Chevaliez S, Pawlotsky JM. Hepatitis C Virus: Virology, Diagnosis and Management of Antiviral Therapy. World Journal of Gastroenterology. 2007 May 7; 13(17):2461-6.
36. Esmat G, Elsharkawy A, El Akel W, Fouad A, Helal K, Mohamed MK, Attia D, Khattab H, Doss W, Labib S. Fibroscan Of Chronic HCV Patients Coinfected With Schistosomiasis. Arab Journal of Gastroenterology. 2013; 14(3):109-12.
37. Ng J, Wu J. Hepatitis B- And Hepatitis C-Related Hepatocellular Carcinomas in the United States: Similarities and Differences. Hepattis Monthly. 2012; 12(10 HCC):e7635.
38. Mauss S, Berg T, Rockstroh J, Sarrazin C, Wedemeyer H. Hepatology - a Clinical Textbook. 6th ed. Düsseldorf: Flying Publisher, 2015 [Google Scholar].
39. Martin NK, Hickman M, Hutchinson SJ, Goldberg DJ, Vickerman P. Combination Interventions To Prevent HCV Transmission Among People Who Inject Drugs: Modeling The Impact of Antiviral Treatment, Needle and Syringe Programs, and Opiate Substitution Therapy. Clinical Infectious Diseases. 2013; 57 Suppl 2(Suppl 2):S39-45.
40. Shivkumar S, Peeling R, Jafari Y, Joseph L, Pant Pai N. Accuracy of Rapid and Point-of-Care Screening Tests for Hepatitis C: A Systematic Review and Meta-Analysis. Annals of Internal Medicine. 2012; 157(8):558-66.
41. Aspinall EJ, Corson S, Doyle JS, Grebely J, Hutchinson SJ, Dore GJ, Goldberg DJ, Hellard ME. Treatment of Hepatitis C Virus Infection among People Who Are Actively Injecting Drugs: A Systematic Review and Meta-Analysis. Clinical Infectious Diseases. 2013; 57 Suppl 2:S80-9.
42. World Health Organization. Guidelines for the screening, care and treatment of persons with hepatitis C infection. Available from: http://apps.who.int/iris/bitstream/10665/111747/1/9789241548755_eng.pdf. [Pub Med]
43. Chen TY, Ding EL, Seage Iii GR, Kim AY. Meta-analysis: increased mortality associated with hepatitis C in HIV-infected persons is unrelated to HIV disease progression. Clinical Infectious Diseases. 2009; 49(10):1605-15.
44. Thein HH, Yi Q, Dore GJ, Krahn MD. Natural History of Hepatitis C Virus Infection in HIV-Infected Individuals and the Impact of HIV in the Era of Highly Active Antiretroviral Therapy: A Meta-Analysis. AIDS. 2008; 22(15):1979-91.
45. Wilkins T, Malcolm JK, Raina D, Schade RR. Hepatitis C: Diagnosis and Treatment. American Family Physician. 2010; 81(11):1351-7.

46. Liang TJ, Ghany MG. Current and Future Therapies for Hepatitis C Virus Infection. New England Journal of Medicine. 2013 May 16; 368(20):1907-17.
47. Halliday J, Klenerman P, Barnes E. Vaccination For Hepatitis C Virus: Closing In On An Evasive Target. Expert Review of Vaccines. 2011; 10(5):659-72.
48. Ozaras R, Tahan V. Acute Hepatitis C: Prevention and Treatment. Expert Review of Anti- Infective Therapy. 2009; 7(3):351-61.
49. De Clercq E. Dancing with chemical formulae of antivirals: A panoramic view (Part 2). Biochem Pharmacol. 2013; 86(10):1397-410.
50. Suzuki S, Izumi N. A Triple Combination Therapy of Simeprevir, Pegylated-Interferon and Ribavirin with Chronic Hepatitis C Virus Genotype 1 Infection. Nihon Rinsho. 2015; 73(2):266-72.
51. Shepard CW, Finelli L, Alter MJ. Global epidemiology of hepatitis C virus infection. The Lancet Infectious Diseases. 2005; 5(9):558-67.
52. Shayeghpour A, Kianfar R, Hosseini P, Ajorloo M, Aghajanian S, Hedayat Yaghoobi M, Hashempour T, Mozhgani SH. Hepatitis C Virus DNA Vaccines: A Systematic Review. Virology Journal. 2021; 18(1):248.

How to cite this article: Tadikonda Rama Rao, Sunkoju Vanisri. Transforming chronic hepatitis C treatment with innovation, efficacy and challenges. *International Journal of Research and Review*. 2025; 12(7): 508-516. DOI: *https://doi.org/10.52403/ijrr.20250752*

******