



On Hepatitis B and Hepatitis C in Hemodialysis Patients: A Case Study of District Swat Pakistan

Sajid Ali Shah *, Raza Muhammad, S.M.Anes Shah, Nawab Ali

Department of Zoology Government Degree College Thana Malakand, KPK Pakistan

*Corresponding author E-mail: shahsajidali442@gmail.com

Received: 08 July 2025. Accepted: 02 August 2025 Published: 2 November 2025

Abstract

Between 64 and 103 million people worldwide suffer from a chronic infection. In nations where HCV is highly prevalent, improper injectable drug use and iatrogenic infections, unsterile medical procedures are major risk factors for this blood-borne virus infection. Unsterile medical procedures (iatrogenic infections) and inappropriate injectable drug use are key risk factors for these blood-borne viral infections in areas where HCV prevalence is high. The study's objectives are to document the incidence of hepatitis in the Hemodialysis Patient District Swat, Khyber Pakhtoon Khawa, the length of the patient's hepatitis treatment, and the area that was examined during my examination work in the Swat Region, Malakand Division, Khyber Pakhtoon Khawa, and Pakistan. Surveys and questionnaires were used to gather data for the study. The statistical method used to acquire the data was basic random sampling. 2000 patients in all were chosen in the Swat Region. Illnesses with the hepatitis B and hepatitis C viruses are major global public health issues, especially for hemodialysis patients who are more likely to contract and spread these illnesses. Investigating the prevalence and risk factors for Hepatitis B and Hepatitis C in hemodialysis patients in District Swat of Pakistan is the goal of this study. A sample of hemodialysis patients in district Swat undergoing treatment participated in a cross-sectional study. Laboratory testing, medical histories and data on demographic features have been collected. In addition due to serological testing has been used to investigate whether anti-HCV antibodies and Hepatitis B surface antigen (HBsAg) were present?. Also, statistical analysis has been conducted to assess prevalence rates and identify potential risk factors associated with HBV and HCV infections. The initial findings from hemodialysis testing show that a proper portion of patient in District Swat's are infected with either Hepatitis B or Hepatitis C. The total prevalence of HBV and HCV infections among study participants was determined, as were the prevalence rates among other demographic groups. Potential risk factors including duration of hemodialysis treatment, blood transfusions, and history of invasive surgeries have been examined to investigate their association with HBV and HCV infections in this group. Our study results will highlight on how common Hepatitis B and Hepatitis C infections are present among hemodialysis patients in District Swat. Moreover, the identification of associated risk variables will facilitate the development of targeted preventative and control strategies in the medical department. Using appropriate infection control strategies, educational programs and screening protocols may be possible to improve patient outcomes and lessen the transmission of HBV and HCV infections in hemodialysis settings in the mentioned society as well in the country.

Keywords: Hemodialysis patients, HBV and HCV, Infections due to blood, Transfusion due to blood.

1. Introduction

Liver cancer, cirrhosis, and liver failure can result from the viral illness known as hepatitis B. According to estimates from the World Health Organization (WHO), more than 250 million people globally suffer from a chronic Hepatitis B infection (Ganem & Prince 2004). Liver cancer, cirrhosis, and liver failure can result from the viral illness known as hepatitis C. According to the WHO, more than 70 million people globally have a chronic Hepatitis C infection (Pawlotsky, 2016). In Pakistan, hepatitis B and C are serious public health issues. The prevalence of Hepatitis B and C in the general population aged 15 and older was estimated to be 2.5% and 4.8%, respectively, based on a countrywide study carried out by the Pakistan Medical Research Council (PMRC) in 2017–18 (Ali et al., 2009). Patients on renal dialysis frequently contract hepatitis B and C, and they are more likely to do so because they frequently come into contact with tainted blood supplies, medical equipment, and shared dialysis equipment. Compared to the general population, kidney dialysis patients have a much greater prevalence of hepatitis B and C infections. The total prevalence of hepatitis B and C infections among dialysis patients was 10.3% and 37.2%, respectively, per a meta-analysis published in 2019 (Fabrizi et al., 2019; Li et al., 2020). We refer to [1-5]. The prevalence and risk factors for hepatitis B and C virus infections in hemodialysis patients were evaluated in a study conducted in Karachi, Pakistan. Poor infection control methods were revealed to be a significant risk factor for the high frequen-

cy of hepatitis B and C virus infections among hemodialysis patients (Raza et al., 2017). Saeed et al. (2013) conducted a study in Lahore, Pakistan, to assess the risk factors and prevalence of hepatitis C virus infection among healthcare professionals, including those employed in hemodialysis facilities. Hepatitis is a worldwide health issue. Around 400 million people worldwide are thought to be carriers of the hepatitis B virus (HBV), and more than half a million of them pass away each year from liver illness linked to HBV. One Hepatitis C virus (HCV) infection affects 3.9 million US civilians, with 2.7 million (74%) having a chronic infection, according to the third National Health and Nutrition Examination Survey (NHANES). Approximately 170 million people are chronic carriers of HCV, and 3% of the global population has been infected. A reliable intermediate treatment for people with chronic kidney disease (CKD) is hemodialysis. Since CKD is an immune-deficient condition, blood-borne viral infections, especially HBV and HCV, are a major cause of morbidity and death for hemodialysis patients. 3–5 Patients with CKD who had HBV and HCV infections also have a worse prognosis after transplantation. Blood transfusions, contaminated dialysis equipment and machines, and interpersonal horizontal transmission inside the dialysis units are all potential sources of infection for hemodialysis patients [6]. An increase in HBV infection has been linked to blood transfusions. Long-term hemodialysis patients had a higher risk of infection than those with a shorter history [7]. One month of hemodialysis raises a patient's risk of

testing positive for HBV by 1.47 times. HCV seroprevalence varied by country, ranging from 0.7 to 18.1%. According to Chandra et al. from the Center for Liver Research and Diagnostics in Hyderabad, India, 7% of patients with chronic kidney disease (CKD) who also received hemodialysis or a renal transplant had an HBV infection alone, 46% had an HCV infection, and 37.10% had a coinfection of both viruses. About 8% of patients in the US presently have an HCV infection, which is common in dialysis patients. The Centers for Disease Control (CDC) presently estimates that hemodialysis patients have an annual risk of acute HCV infection of 0.15%. We refer to [8-10]. The combined prevalence of HBV infection and HCV infection among Chinese hemodialysis patients was 11.9% and 41.1%, respectively, higher hemodialysis stays, higher infection durations, and a history of blood transfusions were all associated with HBV/HCV coinfection. [14] The rate of HBV infection among hemodialysis patients in the United States decreased from 3% in 1980 to 0.1% in 1993 due to improved infection management and vaccination availability, and it has stayed constant throughout the past few decades. Dialysis patients, however, have a compromised antibody response to vaccinations. Hemodialysis patients have a high prevalence of HCV infection, which varies between nations (2–6%) and between dialysis facilities within a single nation. Therefore, routine evaluation may be crucial in lowering the burden of HBV and HCV infections among hemodialysis patients. The purpose of this study was to determine the prevalence of HBV and HCV in Tripura, India, hemodialysis patients. The study's objectives were to: (1) determine the prevalence of HBV and HCV among Tripuran hemodialysis patients; (2) examine the mode of transmission of HBV and HCV among hemodialysis patients; and (3) generate ideas for preventative measures. HBV transmission has a complicated epidemiology and can happen to people of any age. Blood and serous fluids contain the highest amounts of HBV, and the most common way that people become infected is by direct virus inoculation from tainted medical equipment or hazardous injections. Births from moms infected with HBV and sexual interaction with infected individuals are two more prominent ways that the virus is spread. (7, 8) Additionally, as the Hepatitis C virus (HCV) is typically conveyed by direct contact with human blood, regular occupational exposure to blood offers a severe risk of transmission (9). (10) Thankfully, reports indicate that the percentage of hemodialysis patients infected with HCV has dropped from 14.4% in 1999 to 4.5% in 2005. Furthermore, the prevalence of HCV in hemodialysis patients varies by country, ranging from 4% to 70% [11-14].

The higher risk for blood-borne infections, primarily HBV and HCV, can be explained by the nature of and frequent contact with blood and saliva [15]. Given that the frequency of viral hepatitis in the patient population primarily determines the risk of transmission, the aim of this study was to evaluate the prevalence of hepatitis B and C among hemodialysis patients in Qazvin province, Iran [16]. Hepatitis B (HBV) and hepatitis C (HCV) viral infections are major causes of morbidity and mortality in hemodialysis (HD) patients in renal dialysis facilities. In the absence of these viruses, managing these patients becomes challenging. HD is a simulated method of preserving hemostasis in patients with acute renal failure, stage IV chronic renal failure, and severe renal impairment [17]. The majority of patients have dialysis for extended periods of time and are subject to the different adverse effects that come with this process. HD patients typically contract the virus nosocomially, and possible risk factors include sharing single-use infusion vials, not properly aseptically handling equipment, contaminated dialysis supplies and equipment, attending staff contamination, and a failure to disinfect devices between patients. However, repeated blood transfusions and chronic vascular exposure can also play a significant role. In addition, irreversible renal impairment in HD patients already compromises their immune systems, making them more vulnerable to infection by these viruses [18]. Because the routes of transmission for these two hepatotropic viruses are the same, co-infection between HBV and HCV is not unusual in highly endemic places. Additionally,

people who are at high risk of parenteral transmission may also have this dual infection [19].

In patients with concurrent HBV/HCV infections, the risk of developing cirrhosis and decompensated liver disease is increased by the possibility of developing hepatocellular carcinoma (HCC). It has been observed that the prevalence of HBV among dialysis patients in India ranges from 3.4 to 43%, whereas the prevalence of HCV falls between 20% and 80%. [20] Because chronic HBV and HCV infections can proceed to hepatic cirrhosis and hepatocellular cancer, they may pose health hazards. Because of systematic screening, immunization programs, HBV infection management measures, and greater viral clearance rates, HBV infection is less common than HCV infection in HD units [21]. The segregation of patients with HBV, the use of dedicated dialysis equipment, and routine screening for HBV infection have really significantly slowed the rise of HBV [22]. Basic infection control procedures and routine HD patient screening for HCV are the cornerstones of HCV infection prevention in HD settings [23].

Except in cases when local epidemics are recorded, it is not recommended to isolate HCV-infected individuals or employ special devices for them. Strict adherence to universal precautions and the isolation of dialysis patients infected with HBV and HCV may help prevent the spread of disease in HD units [24,25]. The purpose of this study was to assess the different routes of transmission that contribute to the pathogenesis of these infections and to ascertain the prevalence of hepatitis B surface antigen (HBsAg) and anti-HCV antibody in patients undergoing HD in our tertiary care hospital.

We are interested to investigate a case study of mentioned patient in famous district Swat of KPK Pakistan. Our aims and objectives are follows:

- To record to occurrence of Hepatitis in hemodialysis patients in district Swat.
- Duration of treatment for hepatitis in the patients.
- To investigate Hepatitis B & C virus infection in individuals of both sexes of swat.

2. Materials and Methods

Our procedure is follows:

2.1 Methods

This study will employ a cross-sectional design, involving the collection of data from a representative sample of hemodialysis patients in District Swat. The sample size will be determined using appropriate statistical methods to ensure adequate power and generalizability of the findings [26,27].

Data will be collected through structured interviews, medical record review, and laboratory investigations. Demographic information, medical history, and potential risk factors will be recorded. Blood samples will be collected to screen for Hepatitis B surface antigen (HBsAg) and anti-Hepatitis C antibodies (anti-HCV) using validated serological tests. The results will be analysed using appropriate statistical techniques [28-31]. Recently some authors have conducted study on diseases using modeling concepts [32,33].

2.2 Study Area

Our investigation effort focused on Zone (3), which is located in the Swat region of Khyber Pakhtoon Khawa, Malakand Division. Swat is a picturesque valley that lies between 34° 34" and 35° 55" North Scopes 72° 08" and 72° 50" East Longitudes. It is bordered by Ghizer and Chitral on the north, and on the east by Buner, Malakand, and Mardan Division, or on the south, and it is protected from the west by the lap of precipitous reaches. According to the February 2023 Census evaluation, the entire (ZONE 3) local authority is 5337.0 km square and has a population of about 2,309,570.0, making it the third largest region in KPK after Peshawar and Mardan. The regional map from Google is shown in figure 1.

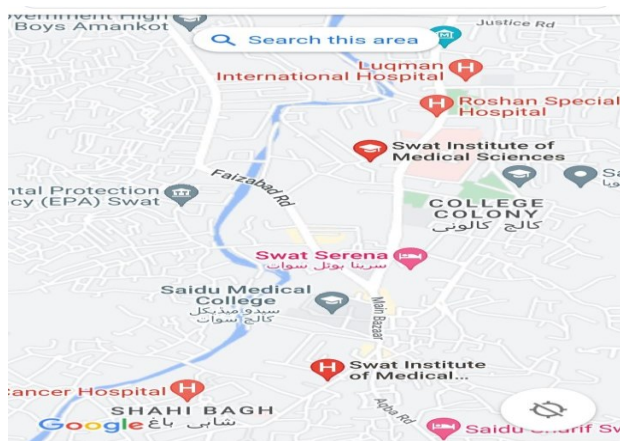


Figure 1. Google Map of study area.

2.3 Data Collection

The exploration was conducted from the start of October 2022 to till the lost of August 2023. The data was collected the research through Surveys and Questionnaire. The statistical technique of data collection was done by the simple random sampling, by using a statistical formula. Data were collected Differences Hospital in the district Swat including Swat institute Medical Sciences and research Center (SIMS) "Saidu Group of teaching Hospital, Nawaz Sharif Kidney Hospital Sangota Swat etc. Each person completed a structured questionnaire that asked about their age, gender, treatment, locality, and history of HCV "patients in family history, including surgery, dental treatment, blood transfusions, anti-HCV vaccination, throwing the blade hair dresser, genetic diseases in the family, living conditions, and occupation." To determine the percentage of +Positive, -Negative cases, all samples were examined in the lab. Data analysis was done using the approach. The percentage was calculated using categorical variables such as total percentage, gender, and age group. The sample was taken from another location. Following collection in the syringe, the blood was moved into an EDTA tube and kept in an icebox at about 20 degrees Celsius until a serological test was conducted. The tubes were centrifuged at 10,000 RPM for 10 minutes after the blood was moved to the diagnostic laboratory.

2.4 Data Collection through Questionnaire

1 Collected Data Through the Questionnaire, Consisting of Variables Such as Age, Gender, Locality & test Status (either +Positive or – Negative) from Different Village's.

2.5 Sample Collection:

Samples are collected from many labs, including the Shifa Clinical Lab, the Saudi Group of Teaching Hospital, the Nawaz Sharif Kidney Hospital Sangota lab, the Answer Lab, and the Swat Institute Medical Sciences and Research Center (SIMS). In order to cleanse the epidermis and make the vein clear and accessible for blood collection, the sample was collected using 70% ethanol-soaked cotton. A belt was fastened around the tight area around the elbow. After injecting roughly 3–4 milliliters of blood into the vein, the syringe needle was carefully withdrawn.

2.6 Serum Test

Our research also included serum tests (anti-HBV and anti-HCV immune chromatography tests). Following serum separation, two drops of serum and one drop of the kit's buffer were applied to serological strips. After five minutes, the reading was recorded.

2.7 Statistical Analysis:

The data will be analyzed statistically to find any significance about the age, gender, locality, and duration of the treatment done. All experiments are representative of at least. Three independent replicates. Data or present as the (mean) standard error of the mean. All statistical analyses were performed using graphed Prism.

3. Results and Explanation

In this section, we discuss different results with details one by one.

3.1 Age Wise Prevalence of HBV and HCV and Negative Infections

Age-wise prevalence shows highest (139.31%) prevalence rate in the group 4 (>60 years) and lowest prevalence (32.4%) in the group 1 (15-30 years).

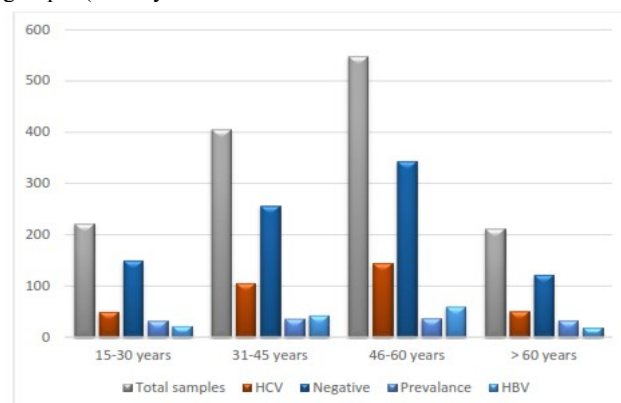


Figure 3.1: Age wise prevalence of HBV and HCV and negative cases.

3.2. District Wise Prevalence of HBV and HCV Hemodialysis Patients in Swat KPK

District-wise prevalence of HBV and HCV in Hemodialysis Patient was found highest (41.7%) in District Swat, and lowest (26.8%) in the District Upper Dir.

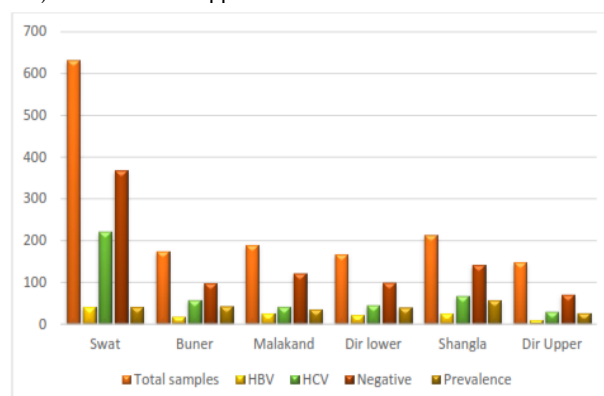


Figure 3.2: Flow chart of district wise prevalence of HBV and HCV.

3.3 Overall and Gender -Wise Prevalence of HBV and HCV in Hemodialysis Patients District Swat

A total of 1480 Peoples samples were examined, out of which 144 (80.8%) were HCV-positive and/or HBV-positive in Hemodialysis Patients. The gender-wise prevalence showed a prevalence of 42.7% and 38.8% in male and female.

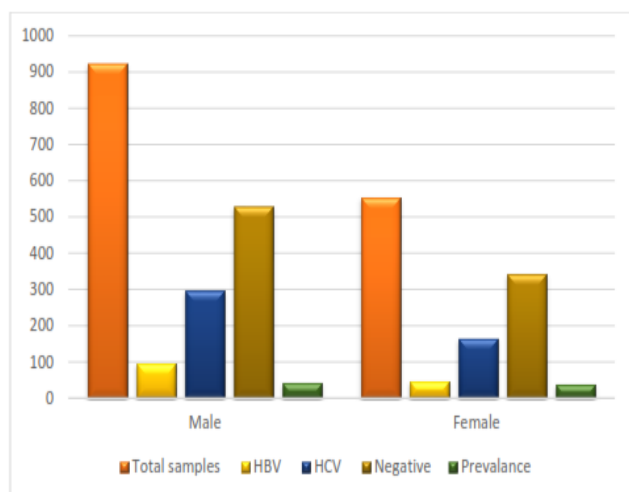


Figure 3.3: Flow chart of overall and gender -wise prevalence of HBV and HCV.

3.4 All Prevalence in Hospital Wise n Hemodialysis Patients District Swat KPK

All the total (1480) Sampling Collected to Different Hospital in Distt Swat Such as, Swat institute of Medical Science & Research Center(SIMS) Total HCV in (Sims) Hospital 614 infected Sampling 178% Nawaz Sharif kidney Hospital infected Sampling HBV 68% and infected Sampling HCV 46% and Lowest HBV and HCV in Swat Teaching Hospital Saudi Sharif Swat HBV (0) HCV 86% in Hemodialysis Patient.

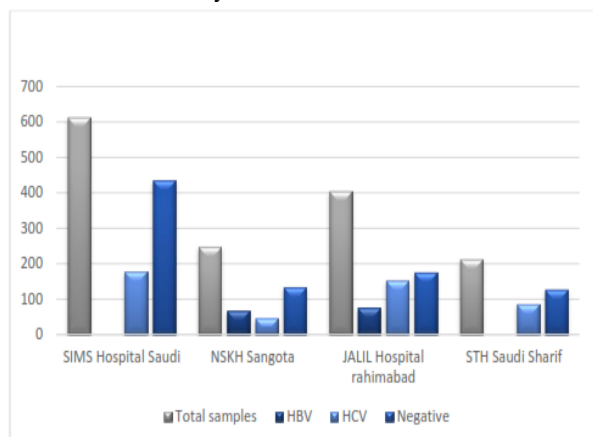


Figure 3.4: Flow chart of all prevalence in hospital wise n hemodialysis patients district Swat KPK.

4. Summary of Results

Although hemodialysis has been shown to raise the risk of blood-borne viral infection, the prevalence varies from hemodialysis center to hemodialysis center, from area to region, from nation to nation, and from high-cost hemodialysis center to low-cost hemodialysis center. The relationship between this heterogeneity and the disease's fundamental prevalence in the community is not fully known. HBV infection among hemodialysis patients ranged from 144% to 44% in the majority of the study, while HCV infection ranged from 463 to 463. Studies on HBV and HCV infection in hemodialysis patients in Swat, Pakistan, have been inconsistent. According to Reddy et al., 43.8% of hemodialysis patients tested positive for HCV, 3.4% tested positive for HBV, and 29.7% tested positive for both HBV and HCV.¹⁸ According to Chandra et al., the rates of HBV, HCV, and coinfection of both viruses were 7, 46, and 37.10% among Swat patients receiving hemodialysis or renal transplantation, respectively.⁶ According to unpublished data from a community survey conducted in Swat, Khyber Pakhtoon Khawa, Pakistan, the prevalence of HBV in the general population is approximately 144%, while that of HCV is less than 29.7%. The incidence of HBV and HCV in Swat's hemodialysis

patients is reflected in the dialysis clinics at the Swat Institute of Medical Science and Research Centre Saudi Sharif Swat, Nawaz Sharif Kidney Hospital Sangota, and Jalil International Hospital Rahim Abad Swat. According to our research, 25.5% of hemodialysis patients had a new HBV infection. It demonstrates that the majority of hemodialysis patients were either unvaccinated or had received their vaccinations shortly before beginning treatment. It most likely prevented the establishment of complete passive immunity. Additionally, SWT patients have lower than normal immunogenicity. Additionally, the study shows that there can be a favorable association. However, 10.9% of patients experienced a new anti-HCV test result. This is comparable to other centers, but an intriguing discovery is that hemodialysis patients are getting infected with HCV at a significantly younger age than the overall population. This could make the spread of HCV more dangerous. It has been noted that every patient with HCV had previously received blood transfusions. None of the patients who had not undergone a blood transfusion tested positive for HCV. It demonstrates that one of the main causes of HCV infection in hemodialysis patients is blood transfusions. All blood is checked before to transfusion, as is well known. The current blood screening technique most likely failed to identify some blood samples that were positive for HBV and HCV. Therefore, PCR or nucleic acid testing should be used to screen blood for HBV and HCV prior to transfusion.¹⁹ Despite their exorbitant cost, these have a very high yield. Another risk factor for infection is the length of hemodialysis. The likelihood of contracting an HBV or HCV infection increases with duration. According to our research, blood transfusions may be the primary reason of the elevated transmission of HBV and HCV infections among SWT patients receiving hemodialysis. Although they might not be as important, other infection sources like surgery and cross-infection might also have a role. Following standard immunization guidelines, all SWT patients should have a hepatitis B vaccination (adults: 2 ml at 0-1-2-6 months and a booster annually if necessary). The blood bank's screening procedures need to be improved further, and modern techniques like PCR and ID-NAT should be used.²⁰ Although voluntary blood donation may lessen the burden of blood-borne viral infections, additional precautions must be taken to lower mortality and morbidity among SWT patients in communities with higher rates of HBV and HCV infection.

4.2 Conclusion

The study concluded that HBV and HCV in Hemodialysis Patient Distt Swat Khyber Pakhtoon Khawa Pakistan, infections are prevalent among the Hemodialysis Patient District Swat. A significantly higher prevalence was found in individuals above 45 years of age. Similarly a higher prevalence rates were recorded in individuals living in rural areas, and those who Transfusions of Blood, Sexual Contact, Drinking water, more People live together a One Room. In the future this study can be extended to more collected data.

4.3 Recommendations

Based on the current study we suggest the following recommendations to control the spread of the considered disease with thesis titled: The Study of HBV & HCV in Hemodialysis Patients District Swat Khyber Pakhtoon Khawa

- Care should be taken while visiting the different hospital in the district Swat 'such as blood transfusion patient' donor, kidney transplant, drinking water, where chances of spread in this diseases increase.
- The infected individual should take precautionary measures such as using separate utensils & during sexual contact.
- Awareness should be made among the public to minimize the transmission of HBV & HCV in hemodialysis patients the blood transfusion.

References

1. Ganem, D., & Prince, A. M. (2004). Hepatitis B virus infection--natural history and clinical consequences. *New England Journal of Medicine*, 350(11): 1118-1129.

2. Pawlotsky JM. (2016) Hepatitis C virus resistance to direct-acting antiviral drugs in interferon-free regimens. *Gastroenterology*. 151(1):70-86.
3. Ali, S. A., Donahue, R. M., Qureshi, H., Vermund, S. H. (2009). Hepatitis B and hepatitis C in Pakistan: prevalence and risk factors. *International Journal of Infectious Diseases*, 13(1): 9-19.
4. Fabrizi, F., Dixit, V., & Messa, P. (2019). Hepatitis B and C virus infection in hemodialysis patients. *Seminars in dialysis*, 32(1),:31-40.
5. Li, Y., Liu, S., Zhang, S., & Lu, H. (2020). Prevention and control of hepatitis B virus infection among hemodialysis patients. *Infectious diseases of poverty*, 9(1): 1-10.
6. Raza, S. M., Muhammad, Y., Hanif, M., & Ali, S. H. (2017). Prevalence and risk factors of hepatitis B and C virus infections in hemodialysis patients: A multicenter study in Karachi, Pakistan. *Hemodialysis International*, 21(2), 192-199
7. Avanchy D. (2004). Hepatitis B virus epidemiology, disease burden, treatment, and current and emerging prevention and control measures. *J Viral Hepat* 11:97-107. 2.
8. WHO global surveillance and control of hepatitis C. Report of a WHO consultation organized in collaboration with the viral hepatitis prevention board, Antwerp, Belgium. *J Viral Hepat* 1999;6:35-47. 3.
9. Zacks SL, Fried MW. (2001). Hepatitis B and C and renal failure. *Infect Dis Clin North Am* . 15:877-99. 4.
10. Steketee RW, Ziarnik ME, Davis JP, et al. (1988). Sero-response to hepatitis B vaccine in patients and staff of renal dialysis centers, Wisconsin. *Am J Epidemiol* 127:772-82. 5.
11. Lofgren B, Nordenfelt E, Lindholm T, et al. (1982). A 10-year follow-up of a hepatitis B epidemic in a dialysis unit. *Scand J Infect Dis* 14:165-69. 6.
12. Chandra M, Khaja MN, Hussain MM, et al. (2004). Prevalence of hepatitis B and C viral infections in Indian patients with chronic renal failure. *Intervirology* 47:374-76. 7.
13. Wang C, Sun J, Zhu B, et al. (2010). Hepatitis B virus infection and related factors in hemodialysis patients in China systemic review and meta-analysis. *Ren Fail* 32:1255-64. 9.
14. Carrilho FJ, Moraces CR, Pinho JR, et al. (2004). Hepatitis B virus infection in hemodialysis centers from Santa Catarina state, Southern Brazil. Predictive risk factors for infection and molecular epidemiology. *BMC Public Health* 4:13.
15. Johnson DW, Dent H, Yao Q, et al. (2009). Frequencies of hepatitis B and C infection among hemodialysis and peritoneal dialysis patients in Asia-Pacific countries: Analysis of registry data. *Nephrol Dial Transplant* 24:1598-603. 11.
16. Finelli, L., Miller, J. T., Tokars, J. I., Alter, M. J., & Arduino, M. J. (2005, January). National surveillance of dialysis-associated diseases in the United States, 2002. In *Seminars in dialysis* 18(1): 52-61. Oxford, UK: Blackwell Science Inc..
17. Sun J, Yu R, Zhu B, Wu J, Larsen S, Zhao W.(2009). Hepatitis C infection and related factors in hemodialysis patients in China: Systemic review and meta-analysis. 31:610-20. 14.
18. Moutinho RS, Perez RM, Pace FH, et al. (2005). Lack of impact of hepatitis C virus coinfection in end-stage renal diseases patients with hepatitis B virus infection. *Transplant Proc* 37: 2080-82. 15.
19. CDC. (1996). Outbreaks of hepatitis B virus infection among hemodialysis patients California, Nebraska and Texas 1994. *MMWR Morb Mortal Wkly Rep* 45:285-89. 16.
20. Finelli L, Miller JT, Tokars JI, et al.(2005). National surveillance of dialysis associated diseases in the United States 2002. *Semin Dial*;18:52-61. 17.
21. Alavian SM, Bagheri-Lankarani K, Mahdavi-Mazdeh M, Nourozi S, et al. (2008). Hepatitis B and C in Dialysis Units in Iran: Changing the epidemiology. *Hemodial Int* 12::37
22. Supram HS, Gokhale S, Sathian B, Bhatta DR. (2015). Hepatitis B Virus (HBV) and Hepatitis C Virus (HCV) Co-infection among HIV infected individuals at tertiary care hospital in western Nepal. *Nepal journal of epidemiology*. 5(2):488.
23. Ringelhan M, McKeating JA, Protzer U. (2017). Viral hepatitis and liver cancer. *Philos Trans R Soc Lond B Biol Sci* . 1732:20160274.
24. Lee S, Kim DY. (2014). Non-invasive diagnosis of hepatitis B virus-related cirrhosis. *World J Gastroenterol* 20(2):445-59.
25. Butt AS, Sharif F. (2016). Viral Hepatitis in Pakistan: Past, Present, and Future. *Euroasian J Hepato-Gastroenterol*. 6(1):7081.
26. Butt, A. S. (2015). Epidemiology of viral hepatitis and liver diseases in Pakistan. *Euroasian journal of hepatogastroenterology*, 5(1): 43.
27. Shah, T., Hussain, W., Ali, N., Sardar, S., Ishaq, M., Rahman, M.U., Ding, L., Qayyum, S. and Khan, I., (2019). Frequency distribution and risk factors of hepatitis B virus and hepatitis C virus infections among thalassemia patients: a regional study. *European journal of gastroenterology & hepatology*, 31(2): 248-252.
28. Ali, N., Hussain, W., Hayat, A., Shah, T., Wen, R., Zeb, I., ... & Khan, I. (2019). Prevalence and risk factors of hepatitis B and C viruses among haemodialysis patients: a multicentric study. *European journal of gastroenterology & Hepatology*, 31(1),:29-33.
29. Malyszko, J., Zawierucha, J., Marcinkowski, W., Prystacki, T., Dryl-Rydzynska, T., Malyszko, J. S., & Matuszkiewicz-Rowinska, J. (2018). The prevalence of hepatitis C and B among patients on hemodialysis and on renal transplantation waiting list in Poland has significantly decreased during the last 10 years. *International Urology and Nephrology*, 50(8):1555-1556.
30. Fabrizi, F., Dixit, V., & Messa, P. (2019). Hepatitis C virus and mortality among patients on dialysis: A systematic review and meta-analysis. *Clinics and research in hepatology and gastroenterology*, 43(3): 244-254.
31. Schweitzer, A., Horn, J., Mikolajczyk, R. T., Krause, G., & Ott, J. J. (2015). Estimations of worldwide prevalence of chronic hepatitis B virus infection: a systematic review of data published between 1965 and 2013. *The Lancet*, 386(10003): 1546-1555.
32. Jimrise, Ochwach, Bonface Obita, and MARK O. OKONGO. (2025). A Mathematical Model for Effective Fungicide Use in Rice Blast Re-Infection." *Journal of Mathematical Analysis and Modeling* 6, 1 (2025): 117-143.
33. Duru, Emmanuel Chidiebere, Michael C. Anyanwu, and Godwin Ce Mbah. (2025). "Mathematical Analysis of a Malaria model with vaccination, treatment and vector control using Sterile-insect technique." *Journal of Mathematical Analysis and Modeling* 6(1): 82-106.