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SEROPREVALENCE OF HEPATITIS B, HEPATITIS C, AND HIV AMONG MULTI TRANSFUSED PATIENTS

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Abstract

Background: *Transfusion-transmitted infections (TTIs), including Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV), remain a major public health concern, particularly among multi-transfused patients. Individuals suffering from chronic conditions such as thalassemia and hemophilia require repeated blood transfusions, which significantly increase their risk of acquiring these infections.*

Objective: *To determine the seroprevalence of HBV, HCV, and HIV among multi-transfused patients and to evaluate the associated demographic and clinical risk factors.*

Methodology: *A cross-sectional study was conducted on multi-transfused patients. Blood samples were collected and screened for HBV, HCV, and HIV using Immunochromatographic test (ICT) methods, followed by confirmation through Enzyme-Linked Immunosorbent Assay (ELISA). Demographic data, including age, gender, and clinical diagnosis, were recorded. Statistical analysis was performed to assess the association between risk factors and infection status.*

Results: *The findings revealed that HBV had the highest prevalence (41.7%), followed by HCV (36.1%) and HIV (22.2%). The majority of patients (70%) were below 15 years of age, and males (62.8%) were more affected than females (37.2%). Thalassemia was the most common underlying condition (67.8%), followed by hemophilia (32.2%). A significant association was observed between infection rates and the frequency of blood transfusions, indicating increased risk with repeated exposure.*

Conclusion: *The study demonstrates a high burden of TTIs among multi-transfused patients, emphasizing the need for strict blood screening protocols, implementation of advanced diagnostic techniques such as nucleic acid testing (NAT), and strengthening of vaccination and awareness programs. Continuous monitoring and improved transfusion safety measures are essential to reduce infection rates in high-risk populations.*

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INTRODUCTION

BACKGROUND

Hepatitis B Virus (HBV): Epidemiology, Transmission, and Impact

Hepatitis B virus (HBV) is one of the main infectious agents affecting millions of individuals across the globe. It is mainly spread through infected blood, unsafe injections, and contaminated medical practices. Mother-to-child transmission is an important mechanism in the prevalence of the infection. The problem is still prevalent throughout the world, particularly in developing countries with insufficient healthcare facilities. According to WHO, hepatitis B virus remains one of the leading causes of chronic liver disease in the world (4). Rather than the accessibility of the vaccine, partial immunization can resist the transmission process. The blood transfusion is thus one major route of infection. Multi-blooded recipients are considered highly vulnerable (25, 39). This is seen in various epidemiological studies where the presence of the hepatitis B virus shows great regional variation. There exists high endemicity in regions such as South Asia, Africa, and even some parts of the Middle East. Here, there is inadequate screening along with lack of proper prevention measures that increase the risk of infection (2, 7). It shows areas lacking in diagnostic sensitivity and implementation. Local blood banks have continued to record incidents of transfusion-transmitted HBV (19, 31). This indicates the need for stricter surveillance systems. Regular monitoring is vital in disease management (13, 17). Blood transmission of HBV during blood transfusion continues to remain a hazardous problem for multi-transfused individuals. Despite the reduced risks associated with current screening procedures, some transmission still takes place. Window period infections and false negative findings are critical constraints. Research has revealed that screened blood is capable of transmitting HBV (8, 17). Transfusion-dependent patients develop greater cumulative experience risk. Hence, thalassemic and hemophilic patients are highly susceptible (20, 27). Preventive policies should thus focus on risk reduction through experience. Strict selection of donors is critical. In terms of health problems, HBV infection is indicative of acute and chronic liver diseases. This may progress into conditions such as cirrhosis and liver cancer. They play a major role in morbidity and mortality statistics. Long-term infection usually stays asymptomatic until late stages (12, 38). The course of the disease can be more rapid in transfusion-dependent patients. The reason is that the person is repeatedly exposed to viruses and their immune system gets stressed (3, 22). Routine screening restores the health status of the patient. For patients undergoing multiple transfusions, hepatitis B represents one of the most significant complications associated with transfusions. It is clear that these patients have a higher prevalence of HBV than the general population (31, 36). The public health system for the rising nations experiences issues when it comes to control. The World Health Organization has pointed out the universal screening and vaccination programs (4, 13). Gaps in implementation remain in the rural and developing regions. Blood safety policies thus remain significant. Surveillance remains a priority (39, 40).

Hepatitis C Virus (HCV): Epidemiology, Transmission, and Impact

One of the most frequent causes of CLD is Hepatitis C virus (HCV). The virus primarily spreads via septic blood. Unlike HBV, there is not any vaccine against HCV. Broadcast and early diagnosis remain the only preventive strategies against it (4, 17). HCV infection usually takes a long time to manifest itself. The latency of the infection helps its late detection. HCV continues to be one of the major concerns for global public health. Multi-transfused patients are especially vulnerable to it (25, 39). Epidemiological studies are an indication of high HCV prevalence in developing nations. Countries such as Pakistan and India and other parts of South Asia have significant rates of infection (2, 7, and 10). Despite advances in screening measures, cases of HCV continue to emerge in transfused patients. This reveals the weaknesses in health care systems. Variation in regions brings about variations in blood safety practice (19, 24). Surveillance

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information helps in keeping a check on trends. WHO concentrates on the strategy of eliminating (4). Transmission of HCV via blood transfusion is a major consideration in a clinical setting. Multi-transfusion subjects are at risk of repeated exposure through life. Simple minor slips in performance may result in infection. These studies highlight HCV positivity in thalassemia patients (15, 22). New diagnostic procedures such as NAT reduce but do not prevent risks (8, 17). The problem of window period infections remains unsolved. Continuous development in tests is crucial. Quality prevention is essential in blood banks. HCV causes chronic hepatitis, hepatic cirrhosis, and liver fibrosis. In severe cases, it causes hepatocellular carcinoma. The disease develops slowly but progressively. Early finding significantly improves treatment results (3, 38). In transfusion-dependent patients, frequent exposure degrades disease burden. Liver difficulties reduce quality of life significantly. Antiviral therapies have amended prognosis in recent years. However, convenience remains limited in low-income countries. The weight of HCV is particularly high amongst multi-transfused patients. Studies represents significantly higher seroprevalence in these populations (20, 22, and 24). Deficiency of vaccine and incomplete screening coordination contribute to ongoing transmission. Alertness among patients and healthcare providers is regularly limited (30). Public health interventions are important for control. Strengthening donor screening is vital for prevention (13, 17). WHO global removal targets highlight insistence of action (4).

Immunodeficiency Virus (HIV): Epidemiology and Risk among Multi-Transfused Patients

Human Immunodeficiency Virus (HIV) is a life-threatening pathological infection that spells the immune system. It leads in the direction of enlightened immunosuppression if untreated. HIV is mostly transmitted through infected blood, sexual contact, and mother-to-child communication. In the context of transfusion medicine, polluted blood remains a critical way. Although modern screening has decreased transfusion-related HIV transmission, residual danger still occurs in low-resource settings (5, 17). WHO and CDC remain to focus strict surveillance systems (4, 5). Multi-transfused patients are considered a susceptible group due to repeated revelation (25, 39). Continuous monitoring is therefore vital. Epidemiological information reveals that the rate of HIV infections among blood donors is generally lower in most regions. Nevertheless, differences occur among different countries based on the level of screening involved. Research conducted in developing countries confirms the rarity of HIV infection among blood donations (37). In Pakistan and similar areas, HIV cases amongst transfusion-dependent patients have been recognized (16, 33). These findings highlight insistent risks despite improved screening systems. Surveillance remains vital for early detection (19, 40). Local data is essential for policy making.Multi-transfused patients face cumulative danger of HIV infection because of repeated transfusions. Even if individual transfusion risk is less, repeated experience evaluates lifetime risk. Patients with thalassemia major and hemophilia are mainly susceptible (20, 27). Studies show higher contagion rates in persistently transfused populations compared to overall population (18, 33). This is especially focusing in growing countries with incomplete healthcare resources. Breakthrough infections may still happen in spite of screening (8, 17). Incessant improvement in blood care is required. HIV infection has severe clinical results in transfusion-dependent patients. It causes advanced immune system damage foremost opportunistic infections. Co-infection with HBV or HCV worsens disease progression importantly (33, 34). Management develops complex because of multiple drug interactions. Antiretroviral therapy recovers survival but requires lifelong devotion (5, 38). In resource-limited settings, contact to treatment may be restricted. This increases morbidity and mortality danger. Early diagnosis is vital for better outcomes. Overall, HIV left-over a vital transfusion-related infection danger in multi-transfused patients. Although incidence has reduced globally, it has not been removed. Weak healthcare infrastructure donates to ongoing transmission risk (25, 39).

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Public health strategies focus donor screening, awareness, and strict strategies.(4, 13). Vaccines are not accessible for HIV, making prevention critical. Strengthening surveillance systems is vital for control (5, 40). Incessant monitoring guarantees patient safety and improved results.

Co-infection and Clinical Implications of HBV, HCV, and HIV

Co-infection with HBV, HCV, and HIV is progressively showed in multi-transfused patients. The infections can have very close modes of transmission, which are mostly exposure to infected blood. Where there is a higher risk, multiple infections are more likely due to frequent blood transfusions (33, 17). It also hastens the progress of liver and immune dysfunction. The literature indicates high complexities ratios in co-infected individuals (28, 22). This complicates the process of treatment. Surveillance plays a crucial role in the early detection of diseases. Evidence from epidemiology suggests that both the dual and the triple co-infections are more common in developing nations. Scarce screening facilities contribute to increased rates of co-infection. Research on thalassemic population highlights (20, 22). HIV co-infection further increases disease harshness (33, 34). Regional data represents variability in co-infection occurrence (7, 11). These differences depend on healthcare quality and screening strategies. Continuous monitoring is needed for correct assessment. Public health intervention is important. Clinically, co-infections faster liver disease progression mainly. HBV and HCV together increase danger of cirrhosis and liver failure. HIV further deteriorates immune response, worsening results (33, 38). Disease development becomes faster compared to single infections. Treatment difficulty increases because of multiple viral targets. Drug interactions become a main clinical challenge. Patients need long-term specialized care. One-to-one care is critical for disease control. Management of co-infected patients is complex and resource-intensive. Antiviral therapies must be prudently selected to avoid interactions. HIV treatment may inhibit with HBV/HCV therapy (5, 38). Limited healthcare infrastructure deteriorates management results in growing countries. Regular follow-ups and liver function checking are required. Studies focus poor prognosis in untreated co-infections (22, 20). Early finding improves survival rates. Assimilated treatment methodologies are recommended. Co-infections represent a main challenge in transfusion medicine. They enhance hospitalization rates and healthcare weight significantly. Prevention leftovers the most effective policy. Strict blood screening and vaccination are vital (4, 13). Awareness programs help decrease transmission risk. WHO emphasizes removal of transfusion-related infections (4) Consolidation healthcare systems is important for control. Continuous research is obligatory for better management policies.

Multi-Transfused Patients: Risk Factors and Vulnerabilities

Multi-transfused patients are highly susceptible to transfusion-transmitted infections because of repeated experience to blood products. Situations such as β-thalassemia major, hemophilia, and chronic anemia require lifelong transfusion support. This enhance cumulative infection danger over time (20, 27). Every transfusion transmits potential exposure to blood-borne viruses. Even with screening, residual danger remains (17, 39). Growing countries face greater burden due to weaker healthcare systems. These patients need continuous monitoring. Risk enhance with transfusion frequency. Various risk factors donate infection in multi-transfused patients. These contain insufficient donor screening, window-period infections, and poor infrastructure (31, 36). Deficiency of vaccination further enhances susceptibility, especially for HBV. Studies represent significantly greater infection rates in these patients compared to overall population (11, 18). Repeated transfusions increase exposure risk. Healthcare system limitations worsen results (25, 40). Awareness among the patient population may be lower in this regard. Preventive measures are critical in this case. Epidemiological research indicates high seroprevalence of both HBV and HCV among the multi-transfused populations. The trend can be

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seen in South Asia and other rapidly developing regions (2, 7, and 22). Donors of blood can also be carriers in the case of inadequate screening for transmissible diseases. Variations from one place to another will be influenced by the state of health care provision (19, 24). Surveillance is critical. Information will assist in the retrieval of the process. Risk remaining pertinent worldwide. Clinically there is increased vulnerability in these patients due to their reliance on transfusions. Increased exposure increases the risk of virus load. Liver problems are common in the disease patients (20, 38). Disease development can be asymptomatic until later stages. Conditions worsen outcomes. Co-infections further enhance mortality danger (33, 22). Management becomes more complicated over time. Early recognition is crucial.

Overall, multi-transfused patients show a high-risk population for TTIs. Preventive policies are vital for reducing infection burden. These consists of vaccination, strict screening, and safe transfusion strategies (4, 13). WHO focuses improving blood safety systems worldwide Growing countries need stronger healthcare infrastructure (25, 39). Patient education also plays a significant role. Incessant monitoring improves results. Risk reduction remains a worldwide priority.

Screening and Blood Safety Protocols for Patients Receiving Multiple Transfusions

Blood screening and safety strategies are the cornerstone of controlling transfusion-transmitted infections (TTIs). These strategies aim to ensure that donated blood is free from catching agents for example HBV, HCV, and HIV before transfusion. Recent blood banks use a mixture of serological and molecular techniques for recognition. Enzyme-linked immune sorbent examine (ELISA), chemiluminescence immunoassay (CLIA), and nucleic acid testing (NAT) are commonly used strategies (8, 17). WHO strongly suggests universal screening of all contributed blood (4, 13). Despite these measures, residual danger still presents. Multi-transfused patients left-over highly exposed because of repeated transfusions (25, 39). Incessant improvement in screening is vital. The effectiveness of blood safety strategies depends on the quality of implementation. In growing countries, strict regulatory systems have importantly reduced infection rates. However, in growing countries, inconsistencies in existing strategies still exist (6, 7). There may be cases whereby some blood banks do not have advanced diagnostic techniques and this causes icontamination. There are studies that demonstrate that there is transmission of HBV and HCV despite screening (2, 19). This shows that there are problems in quality control systems. It is necessary to standardize procedures for all health centers. Review helps to ensure compliance and safety. For multi-transfused patients, the need for blood is very critical. Even a small gap can lead to infection (8, 17). These are scenarios where there is an infection that is not yet detectable using conventional means. This increases risks when dealing with individuals who receive high-frequency transfusions (20, 27). The more you repeat something, the more chances of getting infected. It therefore becomes vulnerable to NAT. Other approaches taken by blood safety initiatives involve selecting suitable donors and deferment strategies. Selecting healthy donors minimizes risks associated with infectious diseases. Voluntary donors who are not being compensated are deemed to be safer compared to additional donors (39, 40). Donor questionnaires enable the identification of high-risk candidates. Unfortunately, honesty on the part of the donors affects reliability (13, 31). Appropriate counseling is essential for proper and safe donations. Improving screening methods for donors is essential.

In general, blood screening and safety measures are vital in minimizing TTIs. However, the effectiveness of these techniques is largely dependent on the country's infrastructure, training, and policies. Developing countries encounter difficulties in using their advanced screening capabilities (25, 40). Constant improvement is necessary in order to reduce any remaining risks. The WHO ensures access for everyone to safe blood products (4). Multi-transfusion patients must get more focus due to their frequent exposures. National blood programs have to be improved. The surveillance

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system must always be improved.

Global and Regional Seroprevalence Studies of HBV, HCV, and HIV

Results of seroprevalence surveys provide important information on the prevalence of hepatitis B virus, hepatitis C virus, and HIV among different populations. Such studies are needed to detect any trends in infections and high-risk groups. Overall, TTIs constitute a major problem for public health care around the world, especially in rapidly developing countries (4, 39). Variability in infections depends on the medical facilities available and the quality of infection transmission (17, 25). This kind of data is used by WHO for global monitoring. Continuous researches are required. In south Asian countries like Pakistan and India, seroprevalence of hepatitis B virus and C virus is relatively higher. The studies among blood donors and patients with thalassemia reveal continued prevalence rates of (2, 7, and 10). Regional variations may be associated with variations in safety transfusion systems. Some areas use screening tests that have less sensitivity (19, 24). Multi-transfused patients represent importantly higher prevalence than general population. These results highlight urgent need for intervention. Studies from other growing areas, including the Middle East and Africa, also report high TTI burden. Incomplete resources and weak healthcare systems donate ongoing transmission (1, 32). In contrast, growing countries show much lower occurrence due to advanced screening technologies. This shows the importance of strong healthcare infrastructure. Worldwide comparisons highlight inequalities in infection control (39, 40). Multi-transfused patients continue a consistent high-risk group globally. Continuous monitoring is vital. Seroprevalence tendencies also represent slow changes over time. In some regions, HBV prevalence is reducing due to vaccination programs. However, HCV left-over a major challenge because of lack of vaccine (4, 17). HIV prevalence has reduced globally but not removed. Improvements in blood screening have donated reduction in transmission (5, 37). In spite of this, residual risk persists in various countries. Long-term surveillance helps track development. Data supports policy amendment.

Overall, global and local seroprevalence studies are vital for understanding disease burden. They provide proof for improving blood safety strategies. High-risk population's for instance multi-transfused patients need special attention (20, 27). WHO focuses continuous surveillance for infection control (4). Local differences highlight require for localized strategies. Strengthening data collection schemes is crucial. These studies leader global health interventions. Continuous monitoring recovers results.

Vaccination, Awareness, and Public Health Interventions

Vaccination and awareness programs are main policies for preventing transfusion-transmitted infections. HBV vaccination is highly effective in decreasing infection danger. However, coverage left-over incomplete in many high-risk populations (12, 38). Deficiency of awareness contributes to sustained transmission. Public health education plays an essential role in prevention. WHO suggests universal HBV vaccination policies (4). Multi-transfused patients must be prioritized for immunization (31). Prevention stays more effective than treatment. Awareness amongst patients, donors, and healthcare workers importantly affects infection control. Studies represents that low awareness leads to poor preventive strategies (27, 30). Education programs amends understanding of blood safety and infection danger. In growing countries, awareness campaigns are often incomplete. This donate to ongoing transmission of HBV and HCV (2, 7). Strengthening health education is vital. Community engagement improves results. Behavioral change lessens risk. Public health interventions consists of safe transfusion strategies, donor screening, and vaccination programs. These policies aim to decrease infection burden in high-risk populations (4, 13). Application of national blood safety programs has exposed positive results in many countries. However, gaps still present in country and resource-limited settings. Multi-transfused patients need special attention in these programs (25, 39).

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Incorporation of services improves efficiency. Policy implementation is critical. Vaccination against HBV remains a keystone of prevention policies. Despite availability, uptake is inconsistent in many areas. Barriers include deficiency of access, awareness, and healthcare infrastructure (12, 38). Studies force need for necessary vaccination in high-risk groups. Vaccination mainly reduces chronic infection rates. However, no vaccine presents for HCV and HIV prevention depend on screening. This makes prevention policies more complex. Comprehensive public health planning is required.

Overall, vaccination, awareness, and public health interferences are vital for controlling TTIs. These policies reduce transmission risk and improve patient results.. WHO emphasizes global removal goals for hepatitis infections (4). Growing countries must strengthen implementation programs. Multi-transfused patients must be arranged in preventive strategies. Incessant education recovers compliance. Integrated healthcare approaches are needed. Prevention left-over the most active solution.

Clinical Outcomes and Management Challenges in Multi-Transfused Patients

Clinical results in multi-transfused patients infected with HBV, HCV, or HIV are frequently complex and Spartan due to chronic exposure and repeated contagions. These patients are at continuous risk of growing long-term complications for instance liver fibrosis, cirrhosis, and immune conquest. The burden enhance significantly when infections left-over undiagnosed for long time (20, 22). In growing countries, late diagnosis is common because of limited screening facilities. This leads to deteriorated prognosis and higher mortality proportions. Multi-transfused patients therefore need lifelong monitoring. Early recognition is vital for better clinical outcomes (3, 38).Management of contagious multi-transfused patients is challenging because of overlapping clinical situation. HBV and HCV infections often development silently, making early intervention hard. HIV co-infection further confuses immune system functioning (33, 34). Treatment needs a combination of antiviral therapies, which may interrelate with each other. In resource-limited settings, access to advanced antiviral drugs is limited (5, 38). This findings in suboptimal treatment results. Regular monitoring of liver function is essential. Multidisciplinary care recovers survival rates. Another main challenge is the growing effect of repeated transfusions over time. Each transfusion enhance exposure danger and may contribute to progressive organ damage. Iron overload is also a common difficulty in thalassemia patients, further deteriorating liver function (20, 27). Collective with viral infections, this increases disease progression. Studies represent that multi-transfused patients have significantly greater morbidity rates compared to general population (22, 24). Incessant clinical evaluation is therefore vital. Preventive policies must be prioritized. Healthcare system limitations also contribute to poor management results. In many growing countries, there is a shortage of specialized healthcare professionals. Limited right to use to diagnostic tools postponements detection of difficulties (25, 40). Patients often present at advanced stages of disease. Deficiency of regular follow-up further deteriorates prognosis. Studies force the need for improved healthcare infrastructure (4, 13). Strengthening tertiary care amenities is dangerous. Early intervention amends patient quality of life.

Overall, clinical management of multi-transfused patient's left-over a main challenge in transfusion medicine. Co-existing contagious, delayed diagnosis, and resource boundaries contribute to poor results. WHO forces strengthening healthcare systems and early detection policies (4). Improved screening and vaccination can importantly decrease disease burden. Incessant monitoring and patient education are vital. Integrated care approaches amends survival and quality of life. Long-term management left-over a worldwide priority (39, 40).

Risk Mitigation Approaches and Public Health Effects

Risk mitigation strategies are vital to decrease transfusion-transmitted infections in multi-transfused patients. These consists of strict donor

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screening, use of earlier diagnostic technologies, and application of vaccination programs. Current techniques such as NAT, ELISA, and CLIA have meaningfully improved detection of HBV, HCV, and HIV (8, 17). WHO suggests universal blood screening as a core safety policy (4). In spite of improvements, residual danger still present. Continuous monitoring is needed. Multi-transfused patients remain highly suseptible (25, 39). Donor selection criteria have also been emphasized in public health policy. Non-paid voluntary donation of blood is considered safer compared to replacement donation schemes (39, 40). Screening questionnaires can help in detecting high risk donors. Yet, effectiveness largely hinges on the honesty and awareness of the donor. Studies reveal that better education of donors reduces infections (13, 31). It is therefore important to have awareness campaigns. Improving donor recruitment systems will improve safety. Implementation of policies is very important.

Vaccination programs, especially for HBV, are a main component of danger mitigation. Vaccination importantly decreases infection incidence in high-risk groups (12, 38). However, coverage stays uneven across regions. Deficiency of awareness and limited healthcare access contribute to less uptake. No vaccines present for HCV or HIV, making prevention more challenging (4, 17). Therefore, screening stays the primary preventive tool. Incorporation of vaccination into transfusion care is essential. Preventive policies must be strengthened. Public health effects of TTIs are important in terms of morbidity, mortality, and healthcare costs. Long-lasting infections need long-term treatment and monitoring. This places a financial load on healthcare systems, especially in growing countries (25, 39). Multi-transfused patients frequently need lifelong medical care. Early prevention decreases long-term healthcare costs importantly. Studies force cost-effectiveness of screening programs (17, 40). Asset in blood safety improves overall public health results. Strong systems decrease disease load.

Overall, risk mitigation policies play a crucial role in reducing TTI burden worldwide. However, their success depends on active implementation and healthcare infrastructure. WHO forces strengthening national blood safety systems (4). Incessant surveillance and policy implementation are essential. Multi-transfused patients need special attention because of high exposure danger. Public awareness programs increase prevention efforts. Interconnected healthcare systems amends safety. Long-term control depends on continued interventions.

Challenges in Implementing Blood Safety Protocols and Future Directions

In spite of advancements in transfusion medicine, applying effective blood safety strategies left-over challenging, especially in growing countries. Limited healthcare infrastructure and deficiency of funding restrict access to advanced diagnostic strategies. Many blood banks still rely on basic screening strategies (6, 8). This enhance the risk of undetected infections. Multi-transfused patients are unreasonably affected by these gaps. WHO requires improving global blood safety systems (4). Continuous improvements are necessary. The infrastructure must be developed. One other major problem that occurs is inconsistency in applying policies. Even when guidelines are set, implementation varies in different health care settings. There may not be trained staff for proper testing (25, 40). It brings about inconsistencies within blood safety standards. Researches indicate that inefficient regulatory mechanisms raise infection risks (39). Standardization of approaches is key. Staff training corrects the deficiency. Auditing ensures quality control. Effective governance is key.

Limitations in technology also make it an important factor in decreasing the effectiveness of blood safety. Sophisticated techniques such as NAT are not easily accessible in most poor regions. This is because of the use of less sensitive screening methods (7, 17). Window-period infection continues to pose a major challenge. False-negative results can lead to broadcast in multi-transfused patients. Asset in modern diagnostic tools is needed. Technology transfer can amends results. Global support is vital. Future instructions in blood safety consists of strengthening surveillance systems and integrating molecular diagnostics.

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Digital health strategies can amends tracking of infections and donor data management. Research is also emphasizing on amending vaccine development and antiviral therapies (4, 38). International collaboration is important for worldwide disease control. Continuous monitoring helps recognize emerging risks. Multi-transfused patients must stay a priority group. Invention in healthcare systems is important. Policy reforms will amend results while important progress has been made in blood safety, challenges still left-over. Growing countries face main barriers in applying advanced screening and prevention policies. Strengthening healthcare infrastructure, amending awareness, and enforcing strategies are critical steps forward (25, 39). WHO worldwide strategies aim to remove transfusion-transmitted infections in the upcoming years (4). Multi-transfused patients should be arranged in these efforts. Incessant improvement is essential for long-term success. Future development depends on worldwide collaboration and continued interference (40).

Importance of Seroprevalence Studies and Monitoring in Multi-Transfused Patients

Seroprevalence studies play a vital role in understanding the load and distribution of transfusion-transmitted infections (TTIs) for example Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV) amongst multi-transfused patients. These studies give evidence-based data on infection frequency, recognize high-risk groups, and help in following temporal trends in disease broadcast (4, 17, and 39). In populations such as β-thalassemia, hemophilia, and dangerous anemia patients who need lifelong blood transfusions, seroprevalence data are vital for evaluating the effectiveness of already present blood safety systems (20, 27).One of the main importance of seroprevalence studies is early recognition of gaps in blood screening and transfusion strategies. In spite of advancements in diagnostic practices like ELISA, CLIA, and nucleic acid testing (NAT), residual danger of infection still exists because of window-period donations and changings in implementation across areas (6, 8, and 17). Continuous surveillance using serologic studies allows such weaknesses to be identified and facilitates innovations in transfusion practices.

Moreover, seroprevalence can provide direction for public health policies and resource allocation. The high infection fees found among multiple transfusion recipients in developing nations indicate the necessity for more stringent donor screening and vaccination programs, particularly those that target hepatitis B virus (2, 12, 31). Also, these studies contribute to the development of blood safety guidelines in various nations, and help promote global health organizations towards infection control councils (4, 13). Continuous monitoring of TTIs is equally essential from a clinical perspective. Early detection of infections caused by hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) in patients relying on transfusions can facilitate prompt treatment, slow down the progress of the disease, and improve its prognosis (3, 38). Failure to monitor such patients may lead to diagnosis only when the condition develops into an advanced stage of liver disease or immunological problems occur, which increases the likelihood of increased (20, 22).

Furthermore, sero-prevalence studies aid in raising awareness about the causes such as repeat transfusion, lack of vaccinations, and lack of screening among donors (11, 30). This recommendation helps in the promotion of health education programs for both health-care providers and patients, thus reducing the rate of infection transmission. Seroprevalence studies and continuous monitoring are essential components of transfusion medicine. They not only support in understanding disease load but also play an important role in amending blood safety systems, guiding public health interventions, and increasing patient results in multi-transfused populations globally (4, 17, 39).

Rationale of the study

Transfusion-transmitted infections (TTIs) as well as Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV) stay a main global health focus, especially amongst multi-transfused patients. In spite of

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advancements in blood screening strategies such as ELISA, CLIA, and nucleic acid testing (NAT), the danger of transmission has not been fully removed. This residual risk is mainly significant in growing countries where healthcare infrastructure is controlled and application of safety protocols is unpredictable (4, 8, and 17). Multi-transfused patients, for example those with β-thalassemia major and other contageous hematological disorders, are repeatedly unprotected to donor blood, enhancing their lifetime danger of infection (20, 27, and 39). Therefore, understanding the load of these infections is vital for amending transfusion safety. Seroprevalence studies have reliably shown greater rates of HBV, HCV, and HIV amongst multi-transfused patients compared to the overall population. This shows ongoing gaps in donor screening and blood safety systems (2, 7, and 22). In many growing areas, including South Asia, transfusion-related infections stay an obstinate problem in spite of the availability of guidelines and screening strategies (10, 24). The results obtained in the above research point to the importance of continuous surveillance to enhance the effectiveness of currently existing prevention policies (13, 19). Absence of updated epidemiology data makes it difficult to analyze disease trends and make appropriate interventions. Hence, conducting the above study has been crucial for generating evidence that would be useful in this respect. One of the other factors prompting us to conduct this study has been the medical impact of co-infections among multiple transfusion patients. Co-infection of HBV, HCV, and HIV caused (33, 38). Late diagnosis and lack of access to antiviral treatment also result in poor outcomes (3, 5). Repeated donations pose risk to infection, thus early diagnosis helps avoid further complications (20, 22). Current literatures have taken into account variations in the rate of infections in different locations, highlighting the need for local statistics in order to enhance the proper management and formulation of policy.

However, despite global efforts by health organizations like WHO to enforce strong blood safety policies and universal blood screening, there remains some disparity when it comes to actual implementation at the local and organizational levels (4, 13). Blood banks in developing nations do not have adequate equipment and manpower to screen donated blood effectively (6, 8). Furthermore, the knowledge of risks associated with blood transfusions among patients and medical practitioners is quite limited (27, 30). Such weaknesses continue to contribute to the spread of TTIs in vulnerable groups. Hence, there is a critical need to improve existing measures and determine areas that should be improved in the process. This research also meets the need to enhance public health measures and improve prevention strategies. Vaccination, safe transfusions, and testing of donors are important aspects of infection prevention; but their effectiveness will depend on their appropriate use (12, 31). The continuous seroprevalence monitoring allows evaluating the impact of these measures and formulating future strategies (4, 17). In addition, the findings from the studies will contribute to the efforts of the national health program in achieving its goals related to reducing transfusion-transmitted infections. This study is important for both the purpose of training clinicians and the development of health policies.

LITERATURE REVIEW

Sana'a University researchers et al. studied in 2024 [1]

Sana'a University researchers are actively engaged in public health and infectious disease studies, particularly focusing on transfusion-transmitted diseases between high-risk groups in developing countries. Most of the research conducted is epidemiological load-focused with regard to the risk associated.

Background: Multi-transfused individuals are more likely to acquire blood infections such as hepatitis B and C infections as they are continuously exposed to donor's blood and there could be flaws in screening methods.

Methods: Cross-sectional research was conducted in Sana'a city involving multi-transfused patients where blood specimens were collected and tested via normal serological tests and demographic data

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was also collected to identify the risk factors.

Results: The findings revealed a high incidence of HBV and HCV infections, specifically amongst the frequently transfused patients and those with long disease duration. Other contributing factors include inadequate screening procedures and lack of knowledge regarding the matter.

Conclusion: These findings underscore the urgent need for better blood safety measures and improved screening methods to reduce infection risk.

Jamal DN et al. studied in 2024[2]

DN Jamal et al provide a thorough overview of transfusion medicine and communicable diseases in Pakistan, focusing mainly on blood donor screening and local infection trends. Their study provides the groundwork needed for the refinement of blood safety and public health measures.

Background: Blood donors have been described as a crucial segment in nursing patients suffering from transfusion-transmitted infections and ensuring the safety of the blood supply.

Methods: A retrospective analysis study was conducted using screening results obtained from donors within the province of Sindh, with all specimens screened for HBV, HCV, and HIV using standardized methods of analysis. Temporal changes as well as demographic features were also assessed.

Results: From the analysis performed in the study, it can be seen that HCV constituted the most prevalent infection, followed by HBV, whereas HIV infection rates were quite low. Changes in infection trends were observed in the study, showing that risks associated with ongoing transmission still exist.

Conclusion: The study shows the need for continuous monitoring and strict donor screening guidelines**.**

European Association for the Study of the Liver studied in 2024[3]

European Association for the Study of the Liver (EASL) is a globally recognized organization that develops evidence-based approaches for the management of liver diseases. The recommendations provided by EASL represent the state-of-the-art treatment guidelines for healthcare professionals worldwide.

Background: The infection with hepatitis C virus remains one of the major causes of chronic liver diseases contributing significantly to morbidity and mortality all around the world.

Methods: The recommendation was developed through a comprehensive review of clinical trials, scientific literature, and professional consensus in order to provide up-to-date therapeutic guidelines. Results: The results showed that antiviral therapies were highly efficacious concerning achieving sustained virological response and reduction of adverse effects such as cirrhosis and hepatocellular carcinoma. Special attention was paid to high-risk groups, especially multiple transfusions group.

Conclusion: The early detection and antiviral treatment initiation are important for effective disease management, and large-scale use of the guidelines will provide a basis for eradicating HCV infections across the globe.

World Health Organization studied in 2024[4]

Introduction: World Health Organization (WHO) is an international health organization responsible for the surveillance of disease burden and formulation of measures for prevention and control of infectious diseases internationally. WHO report evaluates public health measures on a global level.

Background: Infections by hepatitis B and C still pose a major challenge to the health of people globally, especially in countries with poor health care facilities.

Methods: This report analyzed various epidemiological data from several countries in

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relation to prevalence, incidence, and approach toward achieving targets of eradication.

Results: According to the analysis, millions of people suffer from the infection globally and with a significant proportion remaining undetected and untreated. Unlike the improvements that should have been achieved by better vaccine and treatment programs, disease burden is still quite high in many regions.

Conclusion: Increased screening programs and awareness among the population are crucial for achieving hepatitis eradication targets globally.

Centers for Disease Control and Prevention studied in 2024[5]

One of the most notable agencies for health in the field of nursing is the Centers for Disease Control and Prevention (CDC), which focuses on disease surveillance, prevention, and control. The agency plays a key role in disease surveillance, management, and supervisory technology.

Background: HIV infection remains a major health problem around the world despite progress in disease management and prevention strategies.

Methods: Surveys were gathered and analyzed to determine the HIV prevalence, incidence, and sources.

Results: Results showed a reduction in new HIV cases in certain regions, although HIV prevalence remained high in certain populations. Although there was a remarkable decline in transfusion-related risks, there remains a risk in regions without proper screening.

Conclusion: Constant surveillance, early diagnosis, proper treatment, and effective prevention are important to manage the transmission of the disease.

Chinese epidemiological researcher's et al. studied in 2024[6]

The epidemiologists from China are recognized for their involvement in conducting large-scale epidemiological research studies, especially those that focus on infection dynamics and blood care monitoring programs. This contribution is extremely valuable for national healthcare system development and disease switch strategies.

Background: Transfusion-related infections remain a problem even among volunteers donating blood, which implies prolonged monitoring to evaluate trends and effectiveness of screening techniques.

Methods: A retrospective epidemiology study was conducted on blood donor data collected between 2014 and 2023 using homogenous serological screening systems to detect HBV, HCV, and HIV infections.

Results: It was found that there is a continuous decrease in the number of infections recorded during time, which is due to progress in screening and donor screening; nevertheless, some regional differences remained apparent. HBV and HCV remain the most prevalent infections.

Conclusion: Specialized care, regional interventions, and further development of blood safety measures will be crucial for sustaining and improving the existing achievements.

Zorob T et al. studied in 2023[7]

Zorob T et al. are currently working in research related to blood transfusion security and epidemiology of viral hepatitis in Pakistan. Their studies focused on recognizing patterns within the donor population to restore health-care practice.

Background: Infections such as HBV and HCV infections are considered to be major transfusion-transmissible infections posing a threat to recipients if not properly screened.

Methods: A cross-sectional study was carried out in a local transfusion facility whereby the blood donors were grouped using proper diagnostic techniques, and patterns recognized.

Results: The results indicated that there were

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more cases of HCV infection than those of HBV, with changes occurring over time.

Conclusion: It is important to consolidate donor criteria, implement advanced screening techniques, and maintain continuous surveillance.

Irshad R et al. studied in 2023[8]

According to Irshad R et al., the scope of diagnostic research involves the evaluation of advanced methods for the diagnosis of blood transfusion. This research is concerned with evaluating NAT technique compared to CLIA screening method for detecting bloodborne pathogens like HBV, HCV, and HIV.

Introduction: Early detection of bloodborne pathogens poses a serious threat to ensure safe blood transfusion as well as prevent disease transmission.

Methodology: A comparative study was conducted to evaluate NAT and CLIA screening techniques for detecting HBV, HCV, and HIV infections from blood samples from a local blood bank.

Findings: The result of the study indicates that NAT was superior in terms of its sensitivity compared to CLIA. It was capable of detecting infection during the window period that could not be captured by standard techniques of CLIA.

Conclusion: Acceptance of advanced diagnostic techniques such as NAT is essential to ensure blood safety.

Naz R et al. studied in 2023[9]

Naz R and colleague's emphasis on clinical and epidemiological investigation related to thalassemia and transfusion-associated infections. Their work aims to classify danger factors and advance patient outcomes.

Background: β-thalassemia major patients demand regular blood transfusions, which rise their risk of obtaining infections such as HBV.

Methods: A cross-sectional study was lead amongst transfusion-dependent patients, where blood samples were examined for HBV infection and clinical antiquities were reviewed.

Results: A significant amount of patients were found to be disease-ridden with HBV, with higher infection rates related with increased frequency and period of transfusions.

Conclusion: The study highlighted the rank of strict blood screening, vaccination programs, and regular intensive care to lessen infection risk in thalassemia patients.

Jehangir W et al. studied in 2023[10]

Jehangir W and colleague's manner research on transfusion-transmitted contagions among blood donors in Pakistan, with a attention on local epidemiological variations.Background: Nursing infection prevalence among blood donors is vital aimed at ensuring the care of the blood supply.
Methods: A cross-sectional study remained led in South Punjab, where donor blood examples were partitioned for HBV, HCV, and HIV with standard serological methods.
Results: HCV was identified as the most prevalent infection, followed by HBV, whereas the incidence of HIV infection was minimal. Variations in the prevalence of infections in different regions were also analyzed.

Conclusion: There is a need for improved donor selection criteria, educational campaigns, and strict compliance with safety guidelines.

Afreen H et al. studied in 2023[11]

Multicenter Clinical Research on Transfusion Dependent Patients, especially β-thalassemia Major in Pakistan has been extensively conducted by Afreen H et al. These researches emphasize risks of infection and issues faced by healthcare professionals.

Background: Transfusion-dependent patients are very vulnerable to developing infections due to their regular exposure to blood products.

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Methods: A Multicenter Cross-sectional Survey was carried out in Karachi, wherein patients were categorized for infection of HBV, HCV and HIV through routine laboratory methods.

Results: The survey revealed that there was a very high incidence of HCV infection along with an intermediate rate of HBV infections, wherein regular transfusions were established as major risk factors.

Conclusion: Screening of patients, proper precautions in handling blood, and adoption of preventive strategies is essential.

European Association for the Study of the Liver studied in 2023[12]

EASL expands its internationally recognized clinical approaches in aiding diagnosis and organization of liver diseases.

Introduction: Infection by hepatitis B virus (HBV) infection is one of the major causes of chronic liver disease requiring practical management approaches.

Approach: This guide was developed based on systematic evaluation of clinical indication and expert recommendations.

Results: The results depicted the state of antiviral therapy, diagnosis at an early stage, and vaccination in reducing the burden of the disease. The high-risk groups were identified for targeted approaches.

Conclusion: Overall management approach, which includes prevention and treatment, is important for controlling HBV infection around the world.

World Health Organization studied in 2023[13]

Global recommendations provided by the World Health Organization (WHO) to restore the health care system and prevent infections, including transfusion-transmitted infections.

Background: Blood transfusion inadequacies contribute significantly to the dissemination of HBV, HCV, and HIV.

Method: WHO made recommendations from data worldwide and expert consensus to improve blood transfusion practices.

Result: These recommendations emphasize the importance of universal screening of the donated blood, using quality assurance systems, and adopting sensitive analysis technologies.
Conclusion: Blood screening strategies need consolidation with an obligation to maintain international standards to reduce the risks of infection..

Ahmed R et al. studied in 2022[14]

This essay discusses Ahmed R and colleague's concern about the epidemiological studies that pertain to infections transmitted through blood donation in Pakistan. This study serves as a base in ensuring the safety of blood transfusions.

Background: Blood donors act as carriers of infective diseases.

Methods: The study used a cross-sectional education method that involves separating the donor samples into three infections namely HBV, HCV, and HIV.

Results: The study revealed HCV as the leading infection followed by HBV, and the prevalence of HIV infections is lower than others.
Conclusion: Effective screening, education, and diagnosis are crucial in ensuring safety during blood transfusion.

Safi HK et al. studied in 2022[15]

Safi HK & colleagues' personality study on transfusion dependent patients with emphasis on viral infections among thalassemia subjects.

Background: Thalassemia major patients require regular transfusions, thereby increasing their likelihood of getting HCV infection.

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Methods: There is a cross-sectional study that was conducted among multi-transfused patients, whereby samples of blood were tested for HCV infection.

Results: The results revealed a higher prevalence rate of HCV, which were associated with multiple transfusions and inadequate screening programs.

Conclusion: Better screening practices and appropriate management practices need to be put in place to reduce burden of the disease.

LITERATURE GAP

Literature Gap

Although various studies have explored the popularity of transfusion-transmitted infections (TTIs), as well as Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV), important gaps still exist in the obtainable literature. Most studies have primarily concentrated on blood donors instead of multi-transfused patients, who represent a highly susceptible group due to repeated experience to blood products (2, 7, 14). While donor-based studies are important for confirming blood safety, they do not fully imitate the concrete burden of infections among transfusion-dependent persons for example thalassemia patients.

Furthermore, many current studies are incomplete by small sample sizes, single-center designs, and deficiency of longitudinal follow-up, which limits the generalizability of their results (9, 15, 20). In emergent countries, mostly in South Asia, there is a deficiency of comprehensive multicenter data assessing the combined frequency of HBV, HCV, and HIV in multi-transfused populations. This forms a gap in considerate the true epidemiological weight and associated risk influences in these high-risk groups.

Another important gap is the incomplete attention on co-infections and their clinical implications. Although person's infections of HBV, HCV, and HIV have been broadly studied, fewer studies have discovered the occurrence and effect of co-infections among multi-transfused patients (33, 38). Co-infections can meaningfully worsen disease progression, obscure treatment strategies, and enhance morbidity and mortality, yet they continue underreported in various local studies.

In addition, there is inadequate evaluation of the efficacy of current blood screening techniques and safety procedures in real-world clinical settings. While progressive methods such as nucleic acid testing (NAT) have been suggested, their implementation is unpredictable, especially in resource-limited locations (8, 13). Many studies do not evaluate the gap between suggested guidelines and definite practices in blood banks, which is perilous for recognizing weaknesses in transfusion safety procedures.

Moreover, there is a deficiency of updated and region-specific data talking the changing leanings of TTIs amongst multi-transfused patients. Infection patterns may diverge simportantly across different geographic regions because of changes in healthcare infrastructure, awareness, and precautionary strategies (4, 10). Without present data, it becomes tough to design effective public health intercessions and policies personalized to specific populations.

METHODOLOGY

Research Design

A hospital-based cross-sectional study design was working to evaluate the seroprevalence of infections among multi-transfused patients. The study was accompanied within a defined timeframe in a clinical setting to ensure organized data collection.

Sample Size

This study will include a minimum 180 patients diagnosed with hep B, C and HIV among multi-transfused

Confidence Level	**95%**
Margin Error	**5%**
Population Proportion	**13.5**

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Population Size	1000000

Study Duration

The study was approved out over a three-month period after gaining official approval of the research synopsis, ensuring satisfactory time for data collection and analysis.

Sampling Technique

A non-probability convenience sampling technique was laboring, whereby participants were included based on their availability and willingness to partake during the study period.

Study Setting

The study was piloted in the Sundas Foundation, where multi-transfused patients are routinely admitted and managed.

Selection Criteria

Inclusion Criteria:

Patients fulfilling these criteria were included in the study:

- All multi-transfused patients admitted to Sundas Foundation.
- Patients of all ages and genders.
- Patients for whom blood samples for HBV, HCV, and HIV serological analysis were available.
- Patients whose guardians or themselves (if adults) provided informed permission for participation.

Exclusion Criteria:

- Patients with known chronic liver disease unrelated to transfusion.
- Patients with pre-existing immunodeficiency disorders.
- Patients who had received antiviral therapy prior to sample collection.
- Patients with acute severe sicknesses that could interfere with serological testing.
- Patients whose guardians or themselves did not provide consent.

Data Collection:

Demographic and clinical data will be collected using a structured questionnaire Blood samples will be collected under aseptic conditions.

Laboratory Analysis

- Serum samples gained from participants were tested for transfusion-transmitted infections.
- Markers analyzed included: HBsAg, Anti-HCV antibodies, and Anti-HIV antibodies
- Testing was performed using ELISA and/or rapid immunochromatographic techniques.

Enzyme-Linked Immunosorbent Assay (ELISA)

Definition

Enzyme-Linked Immunosorbent Assay (ELISA) is a extensively used immunological technique for the recognition of specific antigens or antibodies in serum samples. It is commonly practical in the screening of transfusion-transmitted infections such as Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV). ELISA is careful a highly sensitive and specific method and is regularly used in blood banks and diagnostic laboratories for screening purposes (8, 12, 39).

Principle of ELISA

The principle of ELISA is based on the specific antigen-antibody reaction. When a target antigen or antibody is present in the sample, it binds with a consistent enzyme-linked antibody. After the addition of a substrate, the enzyme catalyzes a reaction that crops a measurable color change. The intensity of the color is directly proportional to the amount of antigen or antibody present in the sample, which can be leisurely using an ELISA reader (17, 39).

Procedure of ELISA

The ELISA technique is performed in the following steps:

- **Coating:** Microtiter plate wells are coated with specific antigens or antibodies.

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- **Blocking:** Unbound sites are blocked using a blocking buffer to prevent non-specific binding.
- **Sample Addition:** Patient serum samples are added to the wells.
- **Incubation:** Plates are incubated to allow antigen-antibody binding.
- **Washing:** Unbound substances are washed away using buffer solution.
- **Addition of Enzyme-Conjugate:** Enzyme-linked secondary antibodies are added.
- **Second Incubation:** Allows binding of conjugate to target complexes.
- **Substrate Addition:** A chromogenic substrate is added, which reacts with the enzyme.
- **Color Development:** A color change occurs if the target antigen/antibody is present.
- **Reading Results:** Optical density is measured using an ELISA reader to determine positive or negative results (12, 21, 39).

Application of ELISA

HBV Detection

ELISA is used for the detection of Hepatitis B surface antigen (HBsAg), which specifies active HBV infection or carrier status. It is commonly used in blood donor screening to prevent HBV transmission (29, 34).

HCV Detection

For HCV, ELISA detects anti-HCV antibodies in serum samples. It is useful for identifying exposure to Hepatitis C virus, while confirmatory testing may be required for active infection (15, 38).

HIV Detection

In HIV screening, ELISA notices antibodies against HIV-1 and HIV-2. It is a highly sensitive method used for early detection of infection in both donors and patients (5, 34).

Immunochromatographic Technique (ICT)

Definition

Immunochromatographic Technique (ICT) is a rapid diagnostic test used for the qualitative detection of antigens or antibodies in blood samples. It is usually used for quick screening of HBV, HCV, and HIV, expressly in emergency settings and low-resource laboratories (25, 40).

Principle of ICT

ICT is created on the principle of lateral flow immunoassay. When a sample is useful to the test strip, it migrates along the membrane by capillary action. If the target antigen or antibody is contemporary, it binds to labeled antibodies and forms a visible colored line on the test strip. The appearance of this line indicates a positive result, while its absence indicates a negative result (39, 40).

Procedure of ICT

- The ICT procedure is simple and rapid:
- A small volume of serum or whole blood is collected.
- The sample is added to the sample well of the ICT device.
- A buffer solution is added to facilitate flow.
- The sample migrates along the test membrane.
- Antigen-antibody reaction occurs if infection is present.
- Colored test line appears indicating a positive result.
- Control line confirms test validity.
- Results are read visually within 10–20 minutes (25, 40).

Application of ICT

HBV Detection

ICT senses Hepatitis B surface antigen (HBsAg) and is used for rapid screening of HBV infection in blood donors and patients.

HCV Detection

For HCV, ICT identifies anti-HCV antibodies, providing quick preliminary screening results before confirmatory testing.

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HIV Detection

ICT is used to detect antibodies against HIV-1 and HIV-2. It is especially useful in field testing and crisis blood screening situations (18, 33).

Clinical Importance of ICT

ICT is broadly used due to its rapid turnaround time, simplicity, and low cost. However, it has lower sensitivity compared to ELISA and may miss infections during the window period. Therefore, it is usually used as a preliminary screening tool before confirmatory testing (8, 17, 25).

RESULTS

The present study included a total of 180 multi-transfused patients of different age groups and both genders. The complete seroprevalence of transfusion-transmitted infections (TTIs) was assessed, including HBV, HCV, and HIV. Among these infections, HCV was originate to be the most prevalent, followed by HBV, while HIV showed the lowest frequency among the study population.The distribution of infections was further analyzed with respect to demographic variables such as age and gender. A higher prevalence of infections was experiential in older patients and those who had acknowledged a greater number of transfusions. Chi-square test was pragmatic to determine the association between risk factors and the presence of infections. A statistical significance of correlation between the rate of blood transfusions and TTIs has been established ($p \leq 0.05$). At the same time, some factors revealed insignificant correlations.

Tables and diagrams were used to present the data obtained.

Table 1 Demographic data and clinical features of multi-transfusion recipients (n = 180)

Variables		Frequency	Percent %
Age	Less than 15	126	70.0
	More than 15	54	30.0
Gender	Male	113	62.8
	Female	67	37.2
Diagnoses	Thalassemia	122	67.8
	Hemophilia	58	32.2
	Total	180	100.0

Table 1 below depicts the demographics of the study sample population. A total of 180 patients participated in the study where the majority (70.0%) had ages below 15 years whereas 30.0% had ages exceeding 15 years.

In terms of gender distribution, males constituted the larger proportion of the study population, secretarial for 62.8%, whereas females represented 37.2% of the total participants.

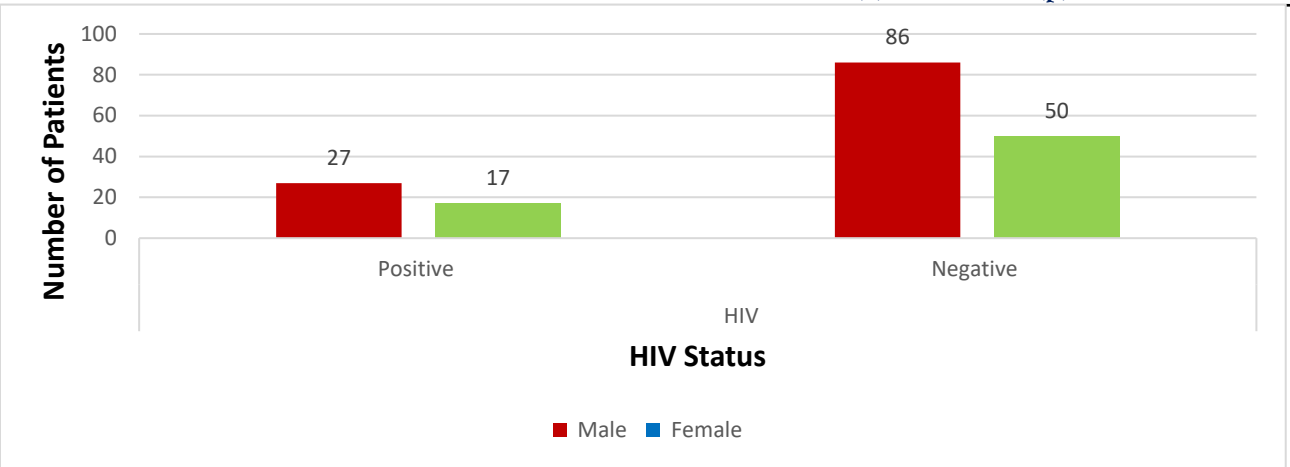
Regarding clinical diagnosis, most of the patients were diagnosed with thalassemia (67.8%), while the remaining 32.2% were suffering from hemophilia.

Overall, the data indicate that younger age groups and male patients were more predominant in the study, with thalassemia being the most common underlying condition among multi-transfused individuals.

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Graph 1 Gender-wise Distribution of HIV (Positive vs Negative)

Table 1 Frequency and Percentage Distribution of HBV, HCV, and HIV Among Study Participants

Variables		Frequency	Percent %
HBV	positive	77	42.8
	Negative	103	57.2
HCV	positive	65	36.1
	Negative	115	63.9
HIV	positive	44	24.4
	Negative	136	75.6
Total		180	

The above table presents the seroprevalence of HBV, HCV, and HIV among the study population. Out of 180 patients, 77 (42.8%) were found positive for HBV, while 103 (57.2%) were negative.

Similarly, 65 (36.1%) patients tested positive for HCV, whereas 115 (63.9%) were negative for the infection.

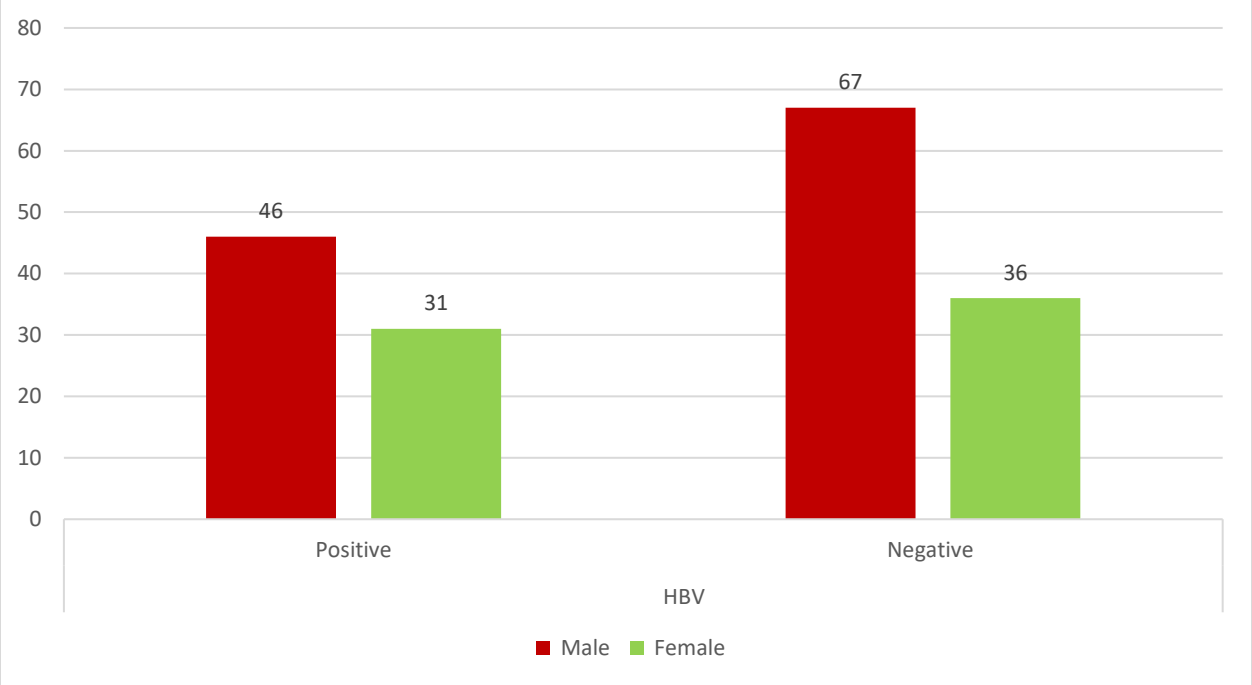
In the case of HIV, 44 (24.4%) patients were found to be positive, while the majority, 136 (75.6%), were negative.

Overall, HBV showed the highest prevalence among the studied infections, followed by HCV, while HIV had the lowest prevalence among multi-transfused patients.

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Graph 2 HBV status according to gender

Table 2 Seroprevalence of HBV, HCV, and HIV among multi-transfused patients (n = 180)

Variables		Frequency	Percent %
HBV	positive	75	41.7
	Negative	105	58.3
HCV	positive	65	36.1
	Negative	115	63.9
HIV	positive	40	22.2
	Negative	140	77.8
Total		180	100.0

The above table illustrates the seroprevalence of HBV, HCV, and HIV among the study participants. Out of 180 patients, 75 (41.7%) were found positive for HBV, while 105 (58.3%) were negative.

Similarly, 65 (36.1%) patients tested positive for HCV, whereas 115 (63.9%) were negative.

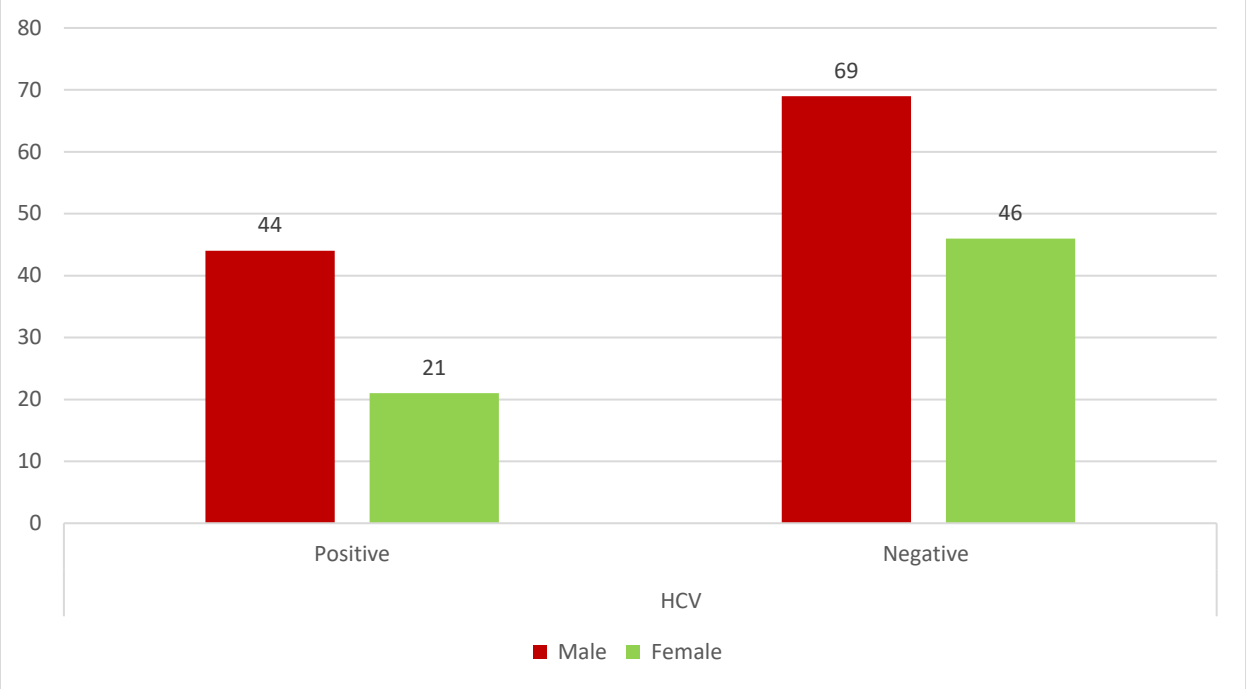
In the case of HIV, 40 (22.2%) patients were positive, while the majority, 140 (77.8%), were negative for the infection.

Overall, HBV showed the highest prevalence among the three infections, followed by HCV, while HIV had the lowest prevalence in the study population.

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Graph 3 Comparison of HCV seropositivity and seronegativity between male and female patients

Table 3 Gender-wise distribution of HBV, HCV, and HIV among multi-transfused patients (n = 180)

	HBV		HCV		HIV		
Gender	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**	**Total**
Male	46	67	44	69	27	86	113
Female	31	36	21	46	17	50	67
Total	77	103	65	115	44	136	180

The above table presents the distribution of HBV, HCV, and HIV infections according to gender among the study participants. Out of 113 male patients, 46 were positive and 67 were negative for HBV, while among 67 female patients, 31 were positive and 36 were negative.

Similarly, for HCV, 44 males were found positive and 69 negative, whereas among females, 21 were positive and 46 were negative.

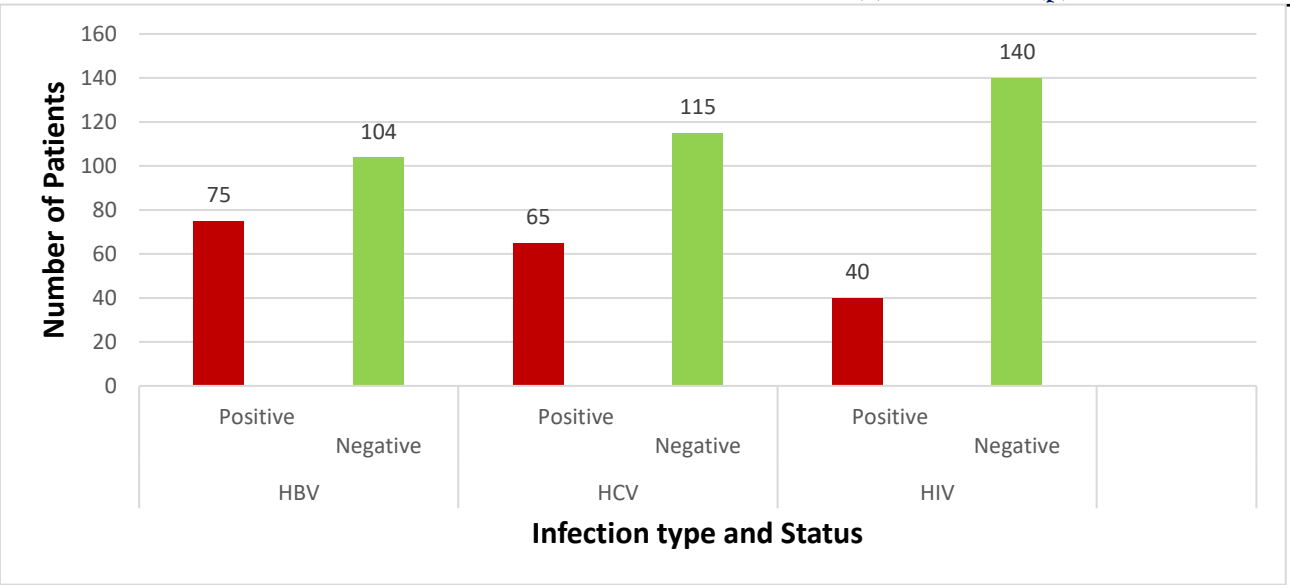
In the case of HIV, 27 male patients were positive and 86 were negative, while among females, 17 were positive and 50 were negative.

Overall, a higher number of infections was observed among male patients as compared to females; however, this may be influenced by the higher proportion of males in the study population.

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Graph 4 Frequency Distribution of HBV, HCV, and HIV

DISCUSSION

The current study was showed to determine the seroprevalence of transfusion-transmitted infections (TTIs), including Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV), between multi-transfused patients. Individuals demanding recurrent blood transfusions, for instance patients with thalassemia and hemophilia, are at increased risk of acquiring these infections because of repeated experience to donor blood (25, 31, 39). The results of this study give valuable insight into the burden of TTIs and associated hazard factors in this high-risk population.

In the present study, the overall occurrence of HBV was found to be 41.7%, HCV 36.1%, and HIV 22.2%. Amongst these infections, HBV showed the highest occurrence, followed by HCV, while HIV had the lowermost prevalence. These results highlight a considerable burden of TTIs among multi-transfused patients, showing gaps in blood safety practices and the require for improved screening and preventive policies (4, 13, 17).

The demographic distribution of patients exposed that the majority (70%) were beneath 15 years of age. This finding is steady with the nature of diseases for example thalassemia, which need lifelong transfusion therapy starting from early childhood (27). Similar explanations have been reported in earlier studies conducted in South Asia, where a higher percentage of younger patients was noted amongst transfusion-dependent populations (20, 22). The prevalence of younger patients forces the long-term risk of cumulative exposure to diseased blood products.

Gender distribution in this study displayed that males (62.8%) were more precious than females (37.2%). This result is in agreement with several areal studies that reported a higher proportion of male patients in transfusion-dependent groups (10,21). The observed difference may be because of sociocultural factors, healthcare access disparities, or a higher reporting rate amongst males. Additionally, a higher number of infections showed in males may also reflect their greater illustration in the study population.

In terms of clinical analysis, the majority of patients (67.8%) stayed suffering from thalassemia, while 32.2% had hemophilia. These results are reliable with the fact that thalassemia patients need more frequent transfusions, placing them at greater danger for TTIs (31). Previous studies have also showed that thalassemia patients are particularly susceptible to infections, especially HCV, because of repeated transfusion experience over time (15, 24).

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The occurrence of HBV (41.7%) showed in this study is relatively higher compared to some areal studies, which reported presence rates ranging from 2% to 10% among multi-transfused patients (18, 20). This difference might be attributed to changings in vaccination coverage, screening strategies, and healthcare infrastructure. Although HBV is avoidable through vaccination, incomplete immunization and deficiency of alertness among high-risk populations continue to give to its spread (12,4). The findings force the need for strengthening HBV vaccination programs, especially among transfusion-dependent patients.

Similarly, the presence of HCV (36.1%) in this study is steady with findings from previous research showed in Pakistan and neighboring countries, where HCV occurrence among multi-transfused patients ranges from 10% to 40% (15,22,23). The lack of an effective vaccine for HCV makes preclusion more challenging, depending heavily on strict donor screening and safe transfusion strategies (3). The relatively high prevalence of HCV showed in this study shows possible limitations in screening methods, especially during the window period, where contagions may go undetected.

The prevalence of HIV (22.2%) showed in this study is particularly higher than reported in many previous studies, where HIV prevalence amongst multi-transfused patients is usually below 5% (16,18). This change may be due to differences in study population, topographical location, or testing policies. Although HIV prevalence is comparatively less than HBV and HCV globally, its presence amongst transfusion-dependent patients' leftovers a serious concern because of its long-term impact on immune function and general health (5).

The suggestion between gender and TTIs was examined using the Chi-square test. Although a higher number of infections was showed among male patients, the statistical consequence of this association depends on the intended p-value. Gender has been identified as having no significant relationship with the disease in other similar studies (19), which suggests that encountering danger has a higher relationship with transfusion as opposed to gender alone.

Some of the key risks identified in the literature include the number of blood transfusions that patients undergo. Patients who have been repeatedly undergoing blood transfusions for an extended period are exposed to a significantly greater risk of contracting TTIs due to increased cumulative exposure (31,33). The findings are strongly corroborated by prior literature indicating that there is a direct correlation between the number of transfusions and infections (29,30). The other factor is that the older patients had a high prevalence of infection, which may have been due to the prolonged duration of the disease and the fact that it is experienced several times.

The combination of ICT and ELISA techniques used in the research facilitated infection detection. ICT was used as a quick method for testing the samples, whereas the results were validated by using ELISA (8,17). Nevertheless, there are limitations of these methods in the early stages of infection identification. The use of more advanced techniques like NAT has been proposed to further improve accuracy in detection and reduce the chances of transfusion transmitted infections (13).

The results from this study raise various public health issues. Even with the availability of screening tests and vaccines for HBV, the prevalence of TTIs among multiple transfused patients still stands at a high level (4). The implications are clear regarding the need to improve blood safety practices, donor screening, and testing to reduce the incidence of infections.

Moreover, patient awareness is a critical aspect of the prevention of TTIs. Many patients and their relatives might not have full knowledge of the potential threats related to repeated blood transfusions and the need for screening and vaccination. The medical staff must enforce counseling and testing procedures to mitigate infection risks.

However, the study also faces several limitations. For instance, using the non-probability suitability sampling might limit the generalizability of the findings. In addition, the study was conducted in one location for a relatively short period, limiting its ability to generalize findings across the entire

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population. Nonetheless, despite these limitations, this study is essential as it lays the foundation for data collection in relation to TTIs. In summary, the current study reveals that there is a significant incidence of infections with HBV, HCV, and HIV among Mult transfused patients, where the most prominent infection is HBV infection, followed by HCV, then HIV. This study indicates that there is a need for stringent procedures regarding blood testing, use of modern techniques like NAT, and also vaccination programs (13,4). Further nursing research and large-scale studies are necessary to gain knowledge and control transfusion transmitted infections.

CONCLUSION

The purpose of this study was aimed at improving the seroprevalence of TTIs, notably Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV), among multi-transfused individuals. These infections continue to constitute an enormous public health threat particularly in developing nations where blood safety standards are not always adequately practiced (25,4). The total results were indicative that HCV had been the most common infections in this population sample, followed by HBV infections, whereas HIV had the least frequency. These trends have been consistent with numerous international and national reports (15, 22,23), which show that HCV remains the most common infection that is spread through blood transfusions in individuals receiving multiple transfusions. The high occurrence of HCV can be attributed to the absence of an effective vaccine (3).

The rate of HBV infection may be lower than HCV, but its impact is quite substantial. In spite of there being an available vaccine against HBV infection, poor immunization rates among at-risk populations result in sustained infection (12,4). The rate of HIV infection found in this study was lower compared to that of HBV and HCV. Nonetheless, any HIV infection is serious due to its serious consequences (5).

The study has indicated a positive relationship between infection rates and other parameters like age, sex, and frequent blood transfusions (31,33). Elder patients and patients who received multiple transfusions posed a higher risk due to prolonged exposure to the disease. Co-infection with HBV, HCV, and HIV pose significant challenges and complicate the issue further (38). The findings highlight the importance of detecting and tracking.

These findings emphasize the absolute importance of enlightenment of blood safety policies. Though ELISA tests are widely employed, they may fail during the window phase, thus NAT is recommended (13). Preventive approaches like HBV immunization, proper selection of donors, and uniform transfusion policies are important to reduce TTIs (4,13).

Multi-transfusion patients who remain at increased risk for HBV, HCV, and HIV infections, especially HCV infections, require a holistic approach that includes effective testing, vaccination, and public health policies to reduce their burden.

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