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REVIEW

Outbreak of hepatitis C virus infection in dialysis settings and prevention strategies

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Abstract

Hepatitis C virus (HCV) is still a major risk in healthcare facilities, especially among hemodialysis patients who maintain constant exposure to potentially infected individuals. Several factors may contribute to the nosocomial transmission of HCV within dialysis units, including multiple blood transfusions, dialysis duration, type of dialysis, incidence of HCV in dialysis facilities, prior organ transplantation, intravenous drug use, gender, advanced age and nosocomial spread in hemodialysis settings. Despite the high burden of HCV among hemodialysis patients, there remains a need for information that focuses on preventive interventions within hemodialysis settings. By providing an overview of the current knowledge, this narrative literature review highlights the outbreak of HCV in dialysis settings and effective preventive interventions relevant to HCV transmission by the expansion of educational initiatives and reinforcing rules at the workplace such as suitable hand hygiene, personal protective equipment, proper dialysis machines, disinfection of surfaces and of the reusable supplies, and commitment to international safety protocols. In addition, enhancing routine screening among hemodialysis patients contributes to a slight reduction in the rate of HCV spread in dialysis centers. Prevention of HCV transmission in the context dialysis facilities requires a comprehensive strategy. Enhancing infection control procedure and the availability of antiviral treatments are important elements that can decrease the HCV burden in dialysis settings. The epidemiology of HCV in dialysis settings is discussed and recommendations for prevention emphasize health practices and determining the interventions that would help improve the management of HCV in hemodialysis care settings.

Keywords: Hepatitis C virus; Dialysis settings; Prevention strategies

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Introduction

Viral hepatitis represents a significant threat to public health. Of the five recognized hepatitis viruses, hepatitis B, C and D are the greatest threats due to the relatively high prevalence of chronic infection and disease burden to the world [1]. The hepatitis C virus (HCV) is a hepatotropic RNA virus with the ability to cause acute and chronic hepatitis. Progressive hepatic damage is the pathogenic process, which finally leads to cirrhosis, decompensated liver disease, and hepatocellular carcinoma [2], and HCV infection influences mortality from cardiovascular illness [3]. The World Health Organization (WHO) has estimated that 47 million people in the world are affected by chronic hepatitis C virus infection, with an estimated exposure of about 1 million cases every year. Over 239,000 individuals lost their lives in 2024 due to hepatitis C, with the most common of those fatalities being cirrhosis and hepatocellular carcinoma, the two main forms of primary liver cancer [4]. HCV has a high level of concentration in a particular geographical area. Globally, about 80 percent of cases are in about 30 countries, with the highest burden recorded in China, India, Pakistan, Ukraine, Russia, and the United States of America. In low- and middle-income countries (LMICs), more than 70% of people who have an active HCV infection are living in areas when diagnostic and treatment options are few [5]. HCV is a bloodborne pathogen that is transmitted by direct contact with infected blood, mainly transfusion, or indirectly through paths of contaminated tools during unsafe injections and other medical interventions. However, even small amounts of blood can carry HCV when percutaneously introduced, particularly in healthcare environments where strict infection control measures are not always observed [6, 7]. Chronic kidney disease (CKD) is a health issue and one of the most common non-communicable diseases in the world. The prevalence of CKD is around 10% worldwide and about 13.1% in low-income countries, compared to over 843.6 million cases of CKD in 2017 across the world. The prevalence of CKD is accelerating rapidly worldwide and it

is expected to be the fifth leading cause of mortality by 2040 [8]. HCV infection has detrimental effects on renal organs, which occur in two ways: immune-mediated renal damage, which is often related to cryoglobulinaemia and direct viral attack on renal tissue. Patients with acute cryoglobulinemic vasculitis commonly present with acute renal dysfunction due to HCV infection, which usually advances to acute kidney injury (AKI). In addition, HCV infection is linked to a higher risk of CKD and the likelihood of developing end-stage renal disease (ESRD) is also high [9]. HCV infection continues to represent a major risk in healthcare environments, particularly in dialysis settings. This review offers insights into the outbreak of HCV in dialysis settings and effective preventive interventions relevant to HCV transmission.

Reflecting the complex association between HCV infection, CKD and infection control, this narrative review has been conducted on studies related to the prevalence of HCV infection in dialysis settings and prevention strategies published between 2000 and 2026 using search engines such as PubMed, Google Scholar and health reports from the WHO. The search criteria included terms such as “Hepatitis C”, “HCV”, “prevalence”, “Diagnosis”, “Infection control”, “Prevention”, “Hemodialysis” and “Dialysis settings”. The inclusion criteria comprised peer-reviewed papers and reports that mainly concentrated on the epidemiology of HCV and infection control in dialysis settings, written exclusively in the English language. Editorials, articles that did not specifically address the research topic or duplicated data were excluded. HCV infection in the hemodialysis population, prevention strategies of HCV spread in dialysis centers were highlighted.

Burden of disease

HCV transmission routes are also observed within the context of medical care, including the administration of unsafe injections and the utilization of inadequately sterilized medical equipment. These factors account for approximately 40 percent of global HCV infections, in addition to the use of blood and blood products that have not undergone proper screening. HCV infection was common among patients receiving maintenance hemodialysis, with a prevalence of 63% in the Arabian Peninsula, which consists of Kuwait, Saudi Arabia, Qatar, and Yemen, whereas in China, it was 41% prevalent. In addition, hemodialysis patients who received blood transfusions were 5.65 times more likely to be infected with HCV than those who did not receive transfusions [10]. Previous studies have reported a high prevalence of anti-HCV antibodies in hemodialysis patients [11–13]. HCV outbreaks among dialysis patients remain common worldwide. According to a report released by the Centers for Disease Control and Prevention (CDC) in 2016, acute HCV infection was reported in 36 cases during 2014 and 2015 in 19 hemodialysis units in eight states. It is reasonable that certain de novo HCV cases arising in diverse clinical environments, including hemodialysis settings, were not recorded in the CDC surveillance data [14]. Access to quality diagnosis and treatment of HCV remains limited and prohibitively expensive for health systems in low- and middle-income countries (LMICs), leaving many without the necessary care [15]. The most rigorous study to date was carried out by the Asia-Pacific Dialysis Registry, which surveyed 201,590 people and found that the percentage of patients with anti-HCV antibodies testing positive ranged between 0.7% and 18.1% in ten geographical regions [16]. The risk of HCV infection is significantly high in patients undergoing hemodialysis, which is explained by frequent blood transfusions, high admission rates and infected dialysis centers. HCV infection and its associated illnesses significantly impact the survival rates of patients undergoing hemodialysis. The mortality rate among individuals on hemodialysis is higher among those infected with HCV than among those who are not infected. The epidemiology of HCV infection among hemodialysis patients reveals significant differences between different geographic locations [17]. A recent systematic review and meta-analysis showed that the global prevalence of HCV infection in hemodialysis patients was 24.3%, varying from 19% to 26% in upper-middle-income countries and 22.7% to 31.1% in lower-middle income countries [18]. These results highlight the necessity of implementing effective preventive measures to reduce acquired HCV infection in dialysis settings. The use of strict infection control measures in developed countries has significantly lowered the number of infections. However, most developing countries still have a high prevalence and which can be explained by the fact that not all countries follow standard and routine hemodialysis precautions or immunization programs and financial resources are lacking [19]. Lapses in infection control measures have been found to be the main causative agent of outbreaks of hepatitis C virus infections. The prevention of such infections has become one of the most urgent issues for nephrology providers, regulatory authorities and public health organizations. Compliance with the recommended infection control procedures has been effective in preventing HCV spread in hemodialysis centers. Moreover, the implementation of regular screening to streamline the early identification of incident HCV infections and the spread of hemodialysis is a necessary part of patient safety and infection prevention programs [20].

Factors associated with HCV transmission in dialysis facilities

Numerous facility- and patient-specific factors contribute to the markedly elevated morbidity and mortality linked to infections among patients with ESRD. These infectious complications not only reduce the health-related quality of life of the patients with ESRD but also bring about a notable extra economic burden [21]. Risk factors related to HCV infection in patients undergoing dialysis include the number of blood transfusions, duration of dialysis, type of dialysis used, incidence of HCV in the dialysis facility, prior organ transplantation, intravenous drug use, sex, old age and nosocomial spread within hemodialysis settings, a scenario that could occur due to a lapse in the standard materials of infection control, spatial contact with an HCV-positive patient, inter-personal cross-infection through the dialysis apparatus, as well as disrupting at the dialyzer membrane or dialyzer reprocessing [22]. Patients infected with HCV and subjected to long-term hemodialysis have mild and non-progressive hepatic disease, presumably because of the destruction of the virus by the dialysis mem-

brane. Nonetheless, such patients manifest poor biochemical indices and complications during transplantation. Hence, it is essential to prevent the acquisition of HCV infection in patients undergoing hemodialysis [23]. The literature has identified numerous transmission routes, but the significantly low rate of infection occurring with peritoneal dialysis compared to hemodialysis and the recent outbreak of contamination in patients neither toxigenic nor receiving transfusion all suggest that a hand-borne route to nosocomial infection is at work [24]. At present, among the various risks of nosocomial transmission of HCV within dialysis units, one major contributor to the spread of HCV infection in hemodialysis centers is the lack of adherence to the prescribed recommendations on infection prevention as they are presented in special guides. In this context, the unsuitable use of medical equipment, lack of compliance with the recommended hygiene standards and the provision of parenteral therapy in an unauthorized or noncompliant way are the dominant types of HCV transmission in hemodialysis facilities [25].

Diagnosis and testing of HCV in chronic hemodialysis patients

Routine screening is crucial in the prevention of CKD, as HCV can be an underlying cause of CKD pathogenesis and is associated with poorer clinical outcomes. Existing guidelines outline the most suitable testing plan and monitoring intervals for patients across various CKD stages. Despite the limited evidence base for diagnosis and assessment, the statements include guidelines and best practices that consider patient and community safety, as well as diagnostic and prognostic aspects [26]. Early detection of HCV infection by screening might lead to therapies that enhance clinical outcomes or decrease transmission risk by identifying patients before they develop severe or irreparable liver damage. Approximately 75 % of people with HCV remain unaware of their infection status [27]. Acute HCV infection can lead to either spontaneous virologic eradication or chronic infection. Irrespective of clinical outcomes, anti-HCV antibodies can be identified in the bloodstream of those exposed to the virus. This fact is the main cause of the high sensitivity of serological tests in monitoring hepatitis C infection, although there are conditions in clinical situations that may decrease the sensitivity. The three possible clinical implications of the presence of HCV antibodies and RNA include active infection, either acute or chronic, which is characterized by concurrently observed seropositivity of the anti-HCV antibodies and a detectable serum HCV RNA; past/resolved infection: evidence of prior exposure but no detectable serum HCV RNA; and false-positive results, which are positive antibody assays but are not supported by the HCV RNA test or by confirmatory serologic tests [28].

There are several laboratory techniques to detect HCV: (1) indirectly, by detecting HCV antibody presence by enzymatic reaction; enzyme immunoassay (EIA) or enzyme-linked immunosorbent assay (ELISA) or light emission (chemiluminescent assay), rapid immunoassay tests, and recombinant immunoblot analyses (RIBA); (2) nucleic acid testing (NAT) utilizing polymerase chain reaction (PCR) methods, including reverse transcriptase PCR (RT-PCR); and (3) Screening for HCV core antigen, alone or in combination with other HCV proteins. There are limitations to each diagnostic procedure: antibodies are not detected in the blood for 2–6 months after the onset of the viral infection; antibodies may persist after the virus has cleared from the body and may not be detectable in immunocompromised patients [29].

The identification of HCV antibodies is given top priority in the diagnostic algorithm, as it indicates the presence of either past or present HCV infection [30]. EIA remains the gold standard for HCV testing and involves embedding viral antigens into microtiter plate wells. In the last ten years, three generations of EIA have been developed for detecting anti-HCV, marking significant progress in hepatitis C screening. The first EIA-1 used a single recombinant antigen based on non-structural (NS4) protein of the HCV genome. Its weaknesses include a high rate of false-positive reactions and reduced sensitivity, with a quantified value of 70% [31]. The second-generation assay, which was developed later, used a combination of recombinant antigens derived from the core region of HCV and nonstructural regions NS3, and NS4. EIA-2 has been enhanced for both sensitivity and specificity compared to EIA-1 [32]. A newly combined antigen from the NS5 region was included in third-generation tests, which also included redesigned core and NS3 antigens. The latest models of immunoassays, namely, fourth-generation tests, have been developed to detect HCV capsid antigens together with antibodies against the core, NS3, NS4, and NS5 regions simultaneously [33].

A study on the laboratory evaluation of HCV infection in patients undergoing hemodialysis in Northeast India showed that the performance of the HCV-combined core antigen–antibody assays was superior to that of other serological assays when compared to the gold standard HCV RNA. This fourth-generation assay produced a Kappa value of 0.947, in contrast to the values of 0.747 and 0.619 for the anti-HCV ELISA and quick detection test, respectively.

For patients receiving hemodialysis, the use of the 4th generation HCV ELISA (combination antigen–antibody assay) for screening and follow-up care may be performed rather than the current use of anti-HCV antibody ELISA in settings with limited resources. A slight increase in price will be more than offset by a higher detection rate yield [34].

Anti-HCV antibody- positive serum requires additional testing for HCV RNA, and nucleic acid testing (NAT) verifies active HCV infection, defined by the presence of HCV RNA or detectable viremia. Based on this, NAT represents the most suitable first-line diagnostic modality in immunocompromised kidney transplant recipients and potentially in patients undergoing hemodialysis, due to the risk of delayed seroconversion in the acute period of HCV infection and the consequential prolonged window period. The decision between EIA and NAT is influenced by the frequency and occurrence of HCV in certain hemodialysis units, as the likelihood of false-negative EIA findings escalates with higher HCV prevalence, which is strongly related to occurrence within the dialysis cohort [35]. In groups with a high prevalence and incidence of HCV, the absolute number of HCV antibody-negative but HCV RNA-positive individuals will also be high, and this group will contribute to the number of possible sources of infection [36].

Prevention strategies of HCV transmission in dialysis facilities

Prevention is widely regarded as the most effective technique to minimize viral infections because it has a less significant financial cost than therapeutic interventions and methods of containing outbreaks. Rigorous precautionary measures for safe-injection procedures must be embraced in settings prone to blood-borne diseases [37]. Hemodialysis units are settings where various patients are treated very closely; this environment enhances the spread of the virus in the absence of standard precautionary practices. Inadequate hand hygiene, insufficient cleaning of dialysis stations, and communal use of medical devices among patients may promote virus transmission [38]. Recognizing the heightened risk of infection in hemodialysis settings, healthcare teams have introduced targeted and more rigorous infection control measures in addition to standard precautions [39]. Such measures include suitable hand hygiene, special dialysis equipment for people who test positive for HCV, and commitment to international safety protocols, which represent a basis for preventing its spread [38]. Lapses in infection control practices, such as, glove use, hand hygiene, environmental surface disinfection, and injectable medication handling, are often observed in most recorded HCV outbreaks in hemodialysis facilities. It is necessary to employ observational audits to encourage adherence to evidence-based therapies and routine assessments [40].

Hand hygiene

Hand sanitation constitutes a pivotal strategy in averting vascular-access-related and viral infections, necessitating dialysis settings to guarantee the provision of readily accessible hand washing basins and alcohol-based hand sanitizers. Hand hygiene opportunities encompass (1) before patient contact, (2) preceding aseptic procedures, (3) following potential exposure to bodily fluids, (4) after patient interaction, and (5) after contacting the patient's environment. An evidence-based intervention package, supplemented by CDC advice, was implemented within a quality improvement initiative. The intervention package included staff training, improvement of hand hygiene practices, systematic audit of vascular access care, and structured staff feedback, resulting in a remarkable decrease in access-related bloodstream infections [41].

Personal protective equipment

Occupational safety gear contains various barriers and respirators that are used separately or collectively to protect mucous membranes, airways, skin, and clothes against exposure to infectious pathogens. The protective gear includes gloves, gowns, masks, eye goggles, face shields, and respirators, all of which are designed to ensure safety. In the hemodialysis environment, gloves should be worn when attending to a dialysis patient, regardless of whether one is in contact with the patient's intact skin (*e.g.*, measuring blood pressure) or handling the patient's equipment at the dialysis station. After handling a patient or station, the recommended practice is to remove gloves and wash hands thoroughly [39].

Safe injection practices

Adherence to adequate injectable medicine preparation protocols using aseptic procedures in a suitable clean environment, together with correct injectable medications administration practices [42].

Dialysis machines

Contain multiple parts that coordinate to remove excess waste from a patient's blood. Gaps in infection control and hazardous methods injection methods create risk factors for blood-borne viruses to threaten hemodialysis patients from reused dialyzers to defective equipment [43].

Disinfection of the surfaces and of the reusable supplies

Proper cleaning, disinfection, and sterilization measures constitute critical elements of the infection control policy implemented within hemodialysis centers. Although the protocols are consistent with those promoted in the general healthcare environments, the significantly high risk of blood contamination introduces a unique sensitivity to the hemodialysis setting. Furthermore, the requirement for regular aseptic access to the patient's vascular system renders the hemodialysis unit more comparable to a surgical suite than a conventional hospital room [44].

Isolation of infected patients

Evidence supporting the use of isolation during hemodialysis for patients infected with HCV is of very low quality. Given the evolution of infection control practices and alignment with current international recommendations, the Kidney Disease: Improving Global Outcome (KDIGO) published its 2020 guideline for the prevention, diagnosis and management of hepatitis C in CKD. HCV guideline asserts that hemodialysis facilities must enforce rigorous infection control protocols to prevent the spread of blood-borne pathogens, including HCV. However, isolating patients infected with HCV throughout hemodialysis sessions is not recommended by these guidelines, except in instances of persistent healthcare-associated transmission, where a localized isolation policy might be warranted [45]. In the case of suspected seroconversion to HCV acquired during hemodialysis, public health authorities should be notified. Lastly, observational audits should be used to strengthen regular evaluation and evidence- supported adherence to interventions [45, 46].

Observing viral status

Patients admitted to hemodialysis units should undergo screening for HCV infection, with alanine aminotransferase (ALT) levels assessed every month and hepatitis C immunoassays or NAT performed biannually. In case of a newly diagnosed HCV infection, all patients at the hemodialysis facility must be screened, the frequency of follow-up testing must be increased, and a thorough examination of the infection management procedures will be conducted [46].

Antiviral treatment

Hemodialysis patients with detectable HCV RNA and an F0–F2 meta-analysis of histological data in viral hepatitis (METAVIR) score are suitable candidates for alpha interferon treatment. Antiviral therapy should also be administered to patients with bridging fibrosis and compensated cirrhosis, and they should be eventual recipients of renal transplantation once they have a sustained viral response [47].

According to the new guidelines, patients with CKD glomerular filtration rate categories G4 and G5, including individuals undergoing dialysis, should be expanded to receive hepatitis C therapy with sofosbuvir-based regimens. In addition, the revised guidelines advocate the use of direct-acting antivirals (DAA) to treat HCV-infected patients with glomerulonephritis without needing a kidney biopsy [48]. In the past two decades, the standard treatment for patients with HCV infection has been interferon-based therapy (interferon (INF) plus ribavirin (RBV)) with a low virological response of not exceeding 50%. Fortunately, the development of DAA in 2011 was a significant step forward in HCV therapy, which resulted in a remarkable improvement in the cure rate of chronic hepatitis C, in individuals with liver disease [49]. The implementation of DAA therapy has revolutionized the treatment of HCV in individuals with CKD. With the 2018 update of the KDIGO guideline for managing HCV in CKD, a considerable amount of new evidence has emerged supporting the use of DAA regimens for patients with CKD [50].

Regardless of the patient's CKD stage, including those undergoing dialysis or recovering from a kidney transplant, DAA treatment is very effective and well-tolerated (with few significant side effects). Various of DAA regimens and stages of CKD have resulted in sustained virologic response rates (SVR12) ranging from 92% to 100%. The incidence of serious adverse events that are considered to be caused by DAA is typically less than 1% of the patients treated. The landscape of HCV-associated immune complex glomerulonephritis treatment is rapidly changing, with clearer guidance emerging on who needs a kidney biopsy before therapy, who can benefit from DAA alone and who should receive immunosuppressive treatment, especially rituximab [51].

A recent study on the association between DAA therapy and long-term outcomes among dialysis patients with HCV infection indicated that DAA medication correlated with enhanced long-term survival and an increased probability of kidney transplantation among patients with ESRD undergoing dialysis and infected with HCV. These results offer empirical data endorsing the clinical advantages of antiviral medication and underscore the necessity of broadening HCV management among patients undergoing dialysis [52]. However, financial constraints and insufficient referrals to hepatologists for therapy continue to pose substantial barriers to the total eradication of HCV. By increasing the availability of DAAs, minimizing the likelihood of HCV transmission in dialysis facilities, and implementing a universal hepatitis B virus (HBV) vaccination program, viral hepatitis might be eradicated as a worldwide health concern within the next ten years [46].

Strategies for adhering to the infection control in hemodialysis units

Improper preparation, handling, and administration of parenteral medications can lead to many breaches in infection control. It is essential to improve infection control education and training for all staff members of hemodialysis sittings to ensure proper procedure adherence and avoid future outbreaks [53]. Minimizing the incidence of healthcare-associated infections and pseudo-outbreaks can be accomplished by (1) proper use of cleaning products and disinfectants, (2) proper maintaining of medical equipment, (3) compliance with hemodialysis water quality criteria and specialized care facility ventilation requirements (such as protective settings, isolation rooms for airborne infections, and operating rooms) and (4) quick water infiltration management in healthcare facilities [54].

Implementation challenges

Non-adherence and suboptimal compliance are factors that create barriers to infection prevention and control. A study conducted in South Africa revealed that hemodialysis practitioners faced several barriers to infection control practices, which were categorized into three groups: (1) Employees' negative attitudes and inefficient habits are examples of individual barriers to infection control, (2) management-related barriers includes a lack of standard operating procedures and inappropriate planning and training, and (3) staff shortages, physical resources, and personal protective equipment shortages among the barriers [55]. Implementing an infection prevention and control program that encompasses a comprehensive set of tactics and interventions would mitigate the risk of infection for healthcare personnel and patients [56].

Healthcare worker training

Developing and implementing healthcare providers' interventions to infection control measures in hemodialysis services offers important benefits in enhancing the quality of care. A study from Rohtak, India, showed that the practices healthcare providers improved significantly after educational interventions. However, although the training improved healthcare personnel' infection control procedures, more study is necessary to determine if they consistently implement evidence-based best practices and remember what they learned [57]. Ongoing education and training for healthcare workers on infection control protocols specific to the hemodialysis facility are essential to raise awareness of the significance of compliance with these procedures, thereby aiding in the reduction of patient infections [58].

Competency assessment

Newly trained nurses should be competent and able to practice autonomously without direct supervision. However, this expectation is paradoxical because their training did not provided them with the information, skills, or confidence needed for independent practice. Therefore, assessing the competence of nurses is important, which is significant for maintaining standards and planning [59]. Numerous studies have demonstrated the diversity of infection prevention control (IPC) compliance

within hemodialysis facilities.

In Pakistan, a study found that most nursing staff were deficient in their knowledge and skills while caring for hemodialysis patients. These findings highlight the necessity for an enhanced focus on training programs among healthcare providers, especially nurses who provide direct patient care, who require more comprehensive hemodialysis training programs and specialized courses [59]. Another study in Japan [60] revealed that although some hemodialysis centers were using different infection control measures, others could not to effectively implement IPC measures because of space constraints, staff shortages, and a temporary lack of personal protective equipment in the hemodialysis facilities. Maintaining high standards of infection control through continuous education, training and organizational support is essential [61].

Quality improvement initiatives

Interventions for quality improvement improve compliance with infection prevention and control in dialysis environments. A scoping review on the impact of IPC quality improvements in hemodialysis facilities indicated that a variety of quality improvement plans including staff education, procedure standardization, and multimodal interventions were highly effective in enhancing compliance with infection prevention measures. Moreover, the usefulness of structured educational efforts in improving patient safety and infection control in clinical settings was further demonstrated by studies that found a substantial drop in infection rates after the interventions [62]. A recent systematic review on the impact of quality improvement interventions on decreasing infection rates and their importance for infection prevention in hemodialysis settings affirms the beneficial effect of continuous quality improvement initiatives on decreasing hemodialysis-related infections. However, the implementation and sustainability of these interventions are greatly affected by regional, economic, and structural disparities within healthcare systems [63].

Audit-based interventions

Auditing is a great tool for ensuring quality clinical practice and inspires healthcare workers to provide better care for their patients. A prospective closed-loop clinical audit was conducted from March to July 2024 in the dialysis unit of Alexandria Main University Hospital in Egypt. A total of 80 patients were randomly selected for insertion of a hemodialysis catheter, 40 in the first audit cycle and 40 in the re-audit cycle. The study highlighted the benefits of applying a closed-loop clinical audit system to promote the ongoing enhancement in the quality of care provided during hemodialysis catheter insertion procedures [64]. Essentially, a clinical audit involves evaluating a clinical result or procedure in relation to clearly defined criteria, made based on the tenets of evidence-based medicine. Comparing clinical practice with standards resulted in the formulation of strategies to improve the quality of daily care [65].

Monitoring adherence to infection-control measures

It is useful to emphasize the need for infection prevention and surveillance approaches. In dialysis units, where there is multidisciplinary interaction between patients and healthcare workers, the challenges faced by healthcare workers in maintaining adherence to IPC procedures should be investigated. A survey on the infection prevention challenges faced by dialysis practitioners in South African dialysis facilities found that the deficiency of personnel, training, and resources obstructs the execution of IPC to guarantee suitable care in dialysis centers. The results indicate that strengthening training programs and fostering adherence to IPC protocols are essential for improving patient care and outcomes in dialysis environments. Moreover, additional examination of the influence of staffing on infection rates is crucial to guide clinical practice recommendations and regulations of pertaining to appropriate dialysis staffing [66]. Furthermore, a recent descriptive cross-sectional study was performed in six governmental hospitals, comprising 112 registered nurses employed in hemodialysis units, to evaluate the efficacy of hemodialysis nurses in executing IPC measures within governmental hospitals in the Gaza Strip. The findings showed that the level of compliance was highest among pediatric hemodialysis nurses, and there were notable variations in IPC performance based on gender, hospital location, and type of hemodialysis service ($p < 0.001$). The performance of hemodialysis nurses is mediocre, exhibiting deficiencies in environmental cleanliness. These findings underscore the necessity for training and supervision to improve infection control and support patient well-being [67]. A recent systematic review showed that the infection control practices have important and robust in decreasing the rate of vascular access infections (VAIs) in patients undergoing hemodialysis [68].

Conclusions

Infection with HCV is one of the most serious global health problems. Hepatitis C is still a neglected disease in dialysis settings. HCV infection can damage the kidneys in two main ways: by triggering the immune system to attack kidney tissue, often through cryoglobulinemia, or by the virus itself directly affecting the kidneys. HCV associated with an elevated risk of CKD and a higher likelihood of progression to ESRD. The risk of developing chronic HCV infection requires greater attention in hemodialysis patients. Key themes highlighted in this review are the outbreak of HCV in dialysis settings, factors related to HCV transmission in dialysis facilities, diagnosis and testing of HCV in chronic hemodialysis patients, prevention strategies to decrease HCV spread across hemodialysis patients comprising suitable hand hygiene, personal protective equipment, safe injection practices, proper dialysis machines, disinfection of the surfaces and of the reusable supplies, antiviral treatment, HCV tracking in the dialysis room and concentrated screening activities to minimize hemodialysis patients' exposure to HCV infection, and strong adherence to infection control measures, including implementation challenges, healthcare worker training, competency assessment, quality improvement, audit-based interventions, and adher-

ence monitoring. Understanding the burden of disease, prevention approaches to HCV transmission in clinical practice, and identifying effective interventions that could enhance the management of HCV in the dialysis settings.

Availability of data and materials

The data and supporting information are available within the article.

Author contributions

AAK—designed and wrote the manuscript.

Ethics approval and consent to participate

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