

Review

Telehealth as an Important Player in the Management of Hepatitis C Virus

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Abstract: Background: Hepatitis C virus (HCV) is a global public health issue that can cause both acute and chronic liver diseases. There is a high risk of HCV burden, but limited access and cost remain a challenge for proper diagnosis and treatment. Leveraging eHealth technology may indicate a viable solution for the management of HCV patients. Objective: To review the literature regarding the role of eHealth, including telemedicine, in the management of HCV. Methods: Databases including PubMed, Google Scholar, Medline, Web of Science, and Science Direct were searched from 1 January 2008 to 30 June 2020 to identify different types of eHealth interventions used for the management of adult HCV patients. Our search also determined the role of telehealth for HCV patients in the current pandemic. Results: Four main categories emerged from this scoping review that includes improving treatment rates via utilizing telehealth services, satisfaction with the telehealth services, disease management, health promotion, and similarity between telehealth and traditional modalities. Conclusions: Current evidence suggests that telemedicine is a cost-effective and unique platform to improve patients' access to quality services that curb the increasing burden of this silent killer in developing countries. This modality can certainly be utilized in the current crisis to manage care for HCV patients efficiently.

Keywords: hepatitis C virus (HCV); telehealth; telemedicine

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1. Introduction

Hepatitis C virus (HCV) is a blood-borne virus that can cause both acute and chronic liver disease depending upon the severity, ranging from mild to severe illnesses [1]. It is a global public health issue with a seroprevalence of around 1.6% [2]. According to the World Health Organization Hepatitis report (WHO, 2017), nearly 71 million individuals are living with HCV, which translates to a worldwide prevalence of 1.0% [1,2]. Moreover, it has been shown that the Eastern Mediterranean region has the highest HCV prevalence of 2.3%, followed by European states at 1.5% [1], while, in other WHO regions, it ranges from 0.5% to 1.0% [1]. The burden of HCV is highest in developing countries: the greatest reported prevalence is in Egypt (22%), followed by Pakistan (4.8%) and China (3.2%) [3].

Marginalized and remote communities mainly suffer from a huge burden of HCV as they face multifaceted barriers, including lack of awareness, dearth of healthcare professionals, unavailability of testing facilities, scarcity of resources, concerns about stigma or social isolation, and treatment costs [4,5]. This in turn hinders patients' access to healthcare services, which leads to poor diagnosis and management of HCV cases [6,7]. Furthermore, the use of unscreened blood products and unsterilized medical/dental equipment, such as needles and syringes, is a common medical practice that has been linked with the transmission of HCV infection [8]. In addition, other potential risk factors such as injectable drug use (sharing of needles), tattooing with reused needles, sexual contact with an infected

person, and mother-to-child transmission also play an imperative role in the spread of HCV infection [1,8,9].

Screening of HCV is vital and can be done by testing for anti-HCV antibodies with a serological test. A positive anti-HCV antibody test directs a person to an HCV ribonucleic acid (RNA) test (a diagnostic test) to confirm an active infection and to initiate timely treatment [1]. It is predicted that almost 1.4 million people who are not treated die each year due to HCV [5,10]. The WHO shared revised guidelines in 2018 and recommended treatment with pan-genotypic direct-acting anti-viral agents (DAAs) for all HCV patients that are 12 years old or older [1]. DAAs are effective as they can cure more than 95% of patients, ultimately resulting in reduced risk of HCV burden. Approximately 5 million patients were treated with DAAs by the end of 2017 [1]. Therefore, much effort is needed to reach the WHO 80% HCV treatment target by 2030, but limited access and cost remain a challenge for proper diagnosis and treatment [1].

Globally, HCV is a main cause of liver disease and it is predicted to be a significant cause of morbidity and mortality in the upcoming years [11]. A WHO report revealed that only 13.1 million, i.e., 19%, were aware of their disease diagnosis. Therefore, there is dire need to improve access to care and treatment for patients with HCV. In order to bridge this gap, innovations are needed that can be incorporated into fragile healthcare systems. Leveraging eHealth technology, i.e., telehealth services, may indicate a viable solution for the management of HCV, particularly in hard to reach, far-flung, and remote communities of the developing world which have no access to HCV healthcare specialists. There are many initiatives that have been taken to seek evidence regarding telehealth innovation for managing HCV patients. Telehealth has often been used interchangeably with telemedicine, which is defined as the delivery of healthcare services remotely by electronic means for “the diagnosis of, treatment, and prevention of disease and injuries, research and evaluation, education of healthcare providers” to improve health [12].

Studies have shown that patients managed via telehealth during the entire course of the treatment showed an increased uptake of HCV drug therapy. This has subsequently led to higher sustained virological response (SVR) rates as compared to patients treated with the traditional model of HCV care, i.e., face-to-face consultations [13,14]. This technology was also found to be an effective and feasible tool for timely screening, diagnosis and treatment of HCV, particularly in underserved populations that are subject to multiple barriers like poverty and a lack of medical experts and primary healthcare centers [15].

In order to accurately gauge the abovementioned research gap, we performed a thorough literature search that provided valuable insights into the application of telehealth to treat HCV patients and also shed light on the use of telehealth among HCV patients in the current pandemic era.

2. Methods

We used the methodological framework outlined by Levac and his colleagues, which was based on previous work by Arksey and O'Malley [16,17]. This systematically directed the steps, which included identifying the relevant studies according to the research aim, selecting appropriate studies and then summarizing and reporting the findings. This search guided the role of telehealth in chronic liver disease such as HCV and can also guide future research. We carried out an electronic literature search on a target group of hepatitis C patients who were managed via telehealth. Studies were selected based on the following criteria: participants (populations), intervention (exposure), outcome(s) of interest, study design, and time duration. We included studies involving adult HCV patients (regardless of gender), whereas adults with other severe morbidities (e.g., HIV, carcinoma, and psychiatric illness) were not eligible. Studies that utilized telehealth for the management of HCV patients were incorporated into this paper, while studies that utilized telehealth services for the capacity building of healthcare professionals and for the management of other chronic ailments were excluded. We included studies demonstrating outcomes related to the utilization of telehealth services for the management (screening,

diagnosis, and treatment) of HCV and expanded our search strategy to identify the role of this innovative modality in the current pandemic. Original studies (experimental and observational) including cross-sectional, case-control, cohort, randomized controlled trials, quasi-experimental studies, clinical control trials, qualitative studies, mixed methods for which full-text articles could be retrieved were mainly used. On the contrary, case studies, case series, systematic reviews, protocols, commentaries, editorials, letters to the editor, unpublished articles (gray literature), symposium proceedings, conference abstracts, and irretrievable documents were not included in this review. All studies published in English, from 1 January 2008 to 30 June 2020, were examined. The studies included in this literature review are presented in Table 1.

2.1. Information Sources and Search Strategy

Studies incorporated in this literature review were rigorously searched by using several electronic databases (from January 2000 onwards): Medline/PubMed, Web of Science, Science Direct, and Google Scholar. We performed hand-searching of the reference lists of the included studies, relevant reviews, or other relevant documents. The literature search was designed and conducted by the review team. The search terms were grouped into the following categories of interest: population (e.g., adult HCV patients), epidemiological studies (e.g., quantitative, qualitative, and mixed methods studies), outcomes (e.g., management of HCV patients via telehealth), and duration (e.g., studies included from January 2000 onwards). Additionally, indexed keywords in the medical subject headings (MeSH) were used to ensure uniform search terms.

2.2. Screening and Selection of Studies

All articles identified from the literature search were uploaded into the EndNote referencing software. Records were screened by two reviewers (AK and NA) independently. A pre-defined screening tool was designed, and a pilot testing was conducted. The selected studies were first screened by titles, then by abstract, and finally by full text to gradually exclude the studies that did not meet the eligibility criteria. Initially, we found a total of 1066 studies from the abovementioned databases. After removing duplicates, 58 were screened based on their titles. Subsequently, in the title screening phase, 38 studies were screened in accordance with the abstracts, removing 20 studies in the process. During the screening of abstracts, full-text articles of 26 studies were assessed as per the eligibility criteria, removing 11 studies in the same process. Later, a single study was found from cross-referencing which was also included. As a result of the whole screening process, we included 16 studies for the purpose of this review as per our pre-defined eligibility criteria [13–15,18–30]. The entire process of study screening and selection is exemplified in the PRISMA flow diagram in Figure 1.

2.3. Data Collection Process

Data were extracted into a customized sheet in Excel that was completed by two independent reviewers (NA, AK) for the eligible studies. The data extraction table was completed by two reviewers to confirm that all the main findings were included. An extraction table is provided in Table 1. The form included primary author, year of publication, study title, country of study, objective, study design, study population, and important findings. Any inconsistencies between the two reviewers in the entire process were discussed and the issue was resolved through mutual consensus.

Table 1. Extraction table.

Author and Year	Study Title	Study Design	Country	Mode of Intervention	Target Population	Study Aim	Important Findings
1. Morey et al., 2019	Increased diagnosis and treatment of hepatitis C in prison by universal offer of testing and use of telemedicine	Cross-sectional	North East England	Telemedicine clinics for hepatitis C virus (HCV) treatment	Prisoners with hep C	To assess the implementation of: <ul style="list-style-type: none"> • Telemedicine clinics (TCs) to increase HCV treatment rates • A universal offer of blood-borne virus testing using dry blood spot testing for prisoners at reception to increase diagnosis 	<ul style="list-style-type: none"> • Telemedicine clinics can substantially increase rates of testing, diagnosis, and treatment of HCV in this high-prevalence population • A universal offer of blood-borne virus testing to prisoners presenting at Her Majesty's Prison reception coupled with linkage to specialist care via telemedicine • Overall, satisfaction with the TC among the prisoners was very high (80% good or excellent).
2. Mohsen et al., 2019	Hepatitis C treatment for difficult to access populations: Can telemetering (as distinct from telemedicine) help?	Retrospective cohort study	Australia	Telementoring program	Treatment of difficult to access populations (DTAPs) with hep C	To determine: <ul style="list-style-type: none"> • Can the Project ECHO (PE) (Extension for Community Healthcare Outcomes) model support primary care clinicians treating HCV and to compare cohort of PE patients with those in a tertiary liver clinic 	<ul style="list-style-type: none"> • PE is an effective model to support primary healthcare providers treating HCV in difficult to access populations • Similar rates of treatment uptake and sustained virological response were noted as compared to patients in tertiary liver clinic
3. Cooper et al., 2018	Direct-Acting Antiviral Therapy Outcomes in Canadian Chronic Hepatitis C Telemedicine Patients	Cohort	Canada	Telemedicine (TM)	HCV patients	To compare: <ul style="list-style-type: none"> • Patient characteristics, fibrosis work-up, and antiviral treatment outcomes in TM and non-TM patients 	<ul style="list-style-type: none"> • Our TM program engages and retains a population that faces many barriers to effective HCV treatment • TM patients initiated HCV therapy and achieved high SVR rates comparable to those obtained using traditional models of care • Positive impact of eHealth in optimizing task-shifting for direct-acting antivirals (DAAs) in HCV-infected patients in underserved outreach clinics • Secondary improvement in access and capacity of clinic was also noted
4. Yoo et al., 2017	The Role of eHealth in Optimizing Task-Shifting in the Delivery of Antiviral Therapy for Chronic Hepatitis C	Retrospective analysis	California	eHealth	Patients with chronic hepatitis C virus (HCV) infection	To assess: <ul style="list-style-type: none"> • Impact of eHealth on task-shifting for HCV patients receiving treatment with direct-acting antiviral (DAA) agents 	<ul style="list-style-type: none"> • Secondary improvement in access and capacity of clinic was also noted
5. Beste et al., 2017	Telemedicine Specialty Support Promotes Hepatitis C Treatment by Primary Care Providers in the Department of Veterans Affairs	Cohort study	US	Video conferencing-based specialist support	Patients with chronic hepatitis C infection	To assess: <ul style="list-style-type: none"> • Whether primary care provider participation in Veterans Affairs Extension for Community Health Outcomes (VA-ECHO) was associated with hepatitis C treatment and sustained virological response 	<ul style="list-style-type: none"> • Veterans Affairs Extension for Community Health Outcomes (VA-ECHO) was positively associated with hepatitis C treatment initiated by primary care providers, without differences in sustained virological response
6. Keogh et al., 2016	Use of tele-health to treat and manage chronic viral hepatitis in regional Queensland	Retrospective audit	Australia	Telehealth	Chronic viral hepatitis patients	To determine: <ul style="list-style-type: none"> • Factors contributing to success of telehealth service and identification of ongoing challenges to the service model 	<ul style="list-style-type: none"> • Our integrated team approach to delivering telehealth services is feasible for regional patients with complex medical needs • Continued expansion of these services is contingent on more flexible delivery networks and better access to videoconferencing infrastructure within general practice settings and at-home settings

Table 1. Cont.

Author and Year	Study Title	Study Design	Country	Mode of Intervention	Target Population	Study Aim	Important Findings
7. Chen et al., 2014	Translational Research of Tele-care for the Treatment of Hepatitis C	Cohort	Taiwan	Telecare program	Chronic viral hepatitis patients	To investigate: • Effectiveness of telecare for the treatment of chronic hepatitis	<ul style="list-style-type: none"> • Telecare system with healthcare communication center model was significant in reducing dropout rate and was more effective with easy access
8. You et al., 2014	A pharmacist-managed telemedicine clinic for hepatitis C care: A descriptive analysis	Cross-sectional	USA	Telemedicine clinic	Hepatitis C patients	To assess: • Patients' perception of a hepatitis C telemedicine clinic in comparison with visits to a clinic in West Los Angeles To determine: • Treatment response and side effect profiles among HCV patients treated with pegylated interferon and ribavirin via telemedicine consultation in different rural locations in Northern California compared with patients treated at traditional hepatology office visits	<ul style="list-style-type: none"> • The use of telemedicine increased opportunities for patients living in remote areas to receive care for hepatitis C management
9. Rossaro et al., 2013	Clinical Outcomes of Hepatitis C Treated with Pegylated Interferon and Ribavirin via Telemedicine Consultation in Northern California	Retrospective analysis	US	Telemedicine consultation	Hepatitis C patients	To assess: • Whether telehealth can provide a feasible mode of healthcare delivery to patients with HCV	<ul style="list-style-type: none"> • The two groups had equivalent sustained virological responses (SVRs). For the TM group, therapy completion was superior and incidence of anemia was lower • Patients with HCV can be safely and effectively treated via telemedicine
10. Nazareth et al., 2013	Successful treatment of patients with hepatitis C in rural and remote Western Australia via tele-health	Cohort	Australia	Telehealth	Hepatitis C patients	To assess: • Whether telehealth can provide a feasible mode of healthcare delivery to patients with HCV	<ul style="list-style-type: none"> • The study confirmed that telehealth is an effective option for the treatment of hepatitis C in rural and remote areas • Treatment through telehealth was found to be non-inferior to face-to-face clinics. Total of 35 telehealth patients completed a satisfaction questionnaire and most indicated that they were happy with the program and would participate again in the future
11. Lloyd et al., 2013	Safety and Effectiveness of a Nurse-Led Outreach Program for Assessment and Treatment of Chronic Hepatitis C in the Custodial Setting	Mixed methods	Australia	Telemedicine	Inmates with chronic HCV	To illustrate: • Feasibility, efficacy, and safety of nurse-led and specialist-supported assessment and treatment of inmates with chronic HCV utilizing telemedicine	<ul style="list-style-type: none"> • This nurse-led and specialist-supported assessment and treatment model via utilizing telemedicine with chronic HCV offered potential to substantively increase treatment uptake and reduce the burden of disease
12. Rossaro et al., 2008	The Evaluation of Patients with Hepatitis C Living in Rural California via Telemedicine	Retrospective analysis	US	Telemedicine	Patients with hepatitis C	To determine: • Whether a hepatology telemedicine clinic will increase access to specialty care especially among those with advanced disease living in an underserved community	<ul style="list-style-type: none"> • Telemedicine was an effective tool for identifying and treating patients with hepatitis C who live in rural communities

Table 1. Cont.

Author and Year	Study Title	Study Design	Country	Mode of Intervention	Target Population	Study Aim	Important Findings
13. Jiménez-Galán et al., 2019	The contribution of telemedicine to hepatitis C elimination in a correctional facility	Observational study	Spain	Teleconsultation	Penitentiary of 1200 inmates	To assess <ul style="list-style-type: none"> The contribution of telemedicine for HCV elimination in a correctional facility in Spain 	<ul style="list-style-type: none"> Telemedicine is an effective tool for HCV elimination in penitentiary correctional facilities where referral to specialists is difficult Overall, 97% achieved a sustained virological response (SVR) The degree of satisfaction of the inmates with telemedicine was high with regard to technical issues as well as the overall assessment
14. Schulz et al., 2018	Using telehealth to improve access to hepatitis C treatment in the direct-acting antiviral therapy era Comparison of hepatitis C treatment outcomes between telehepatology and specialty care clinics in the era of direct-acting antivirals	Retrospective analysis	Australia	Telehealth	HCV patients from a single tertiary hospital	To demonstrate: <ul style="list-style-type: none"> That HCV treatment utilizing telehealth support for care delivery has cure rates similar to onsite care in clinical trials 	<ul style="list-style-type: none"> Telehealth-supported outreach program for patients in regional Australia with HCV produced similar outcomes to on-site clinics There was a considerable saving in time and cost for the patients
15. Case et al., 2019	Comparison of hepatitis C treatment outcomes between telehepatology and specialty care clinics in the era of direct-acting antivirals	Retrospective analysis	United States	Telehealth	HCV patients	To compare: <ul style="list-style-type: none"> The rates of SVR between patients being treated in a telehepatology clinic versus a specialty care clinic (standard of care) in the era of DAAs 	<ul style="list-style-type: none"> Hepatitis C treatment utilizing telehealth technologies to improve access to care does not negatively impact treatment outcomes when compared with specialty care clinics in the era of DAAs
16. Arora et al., 2011	Outcomes of Hepatitis C Treatment by Primary Care Providers	Prospective cohort	New Mexico	Telehealth technology	HCV patients	To improve: <ul style="list-style-type: none"> Access to care for complex health problems such as hepatitis C virus (HCV) infection for underserved populations. Using videoconferencing technology, ECHO trains primary care providers to treat complex diseases 	<ul style="list-style-type: none"> ECHO model is an effective way to treat HCV in underserved communities. Implementation of this model would allow other states and nations to treat more patients with HCV

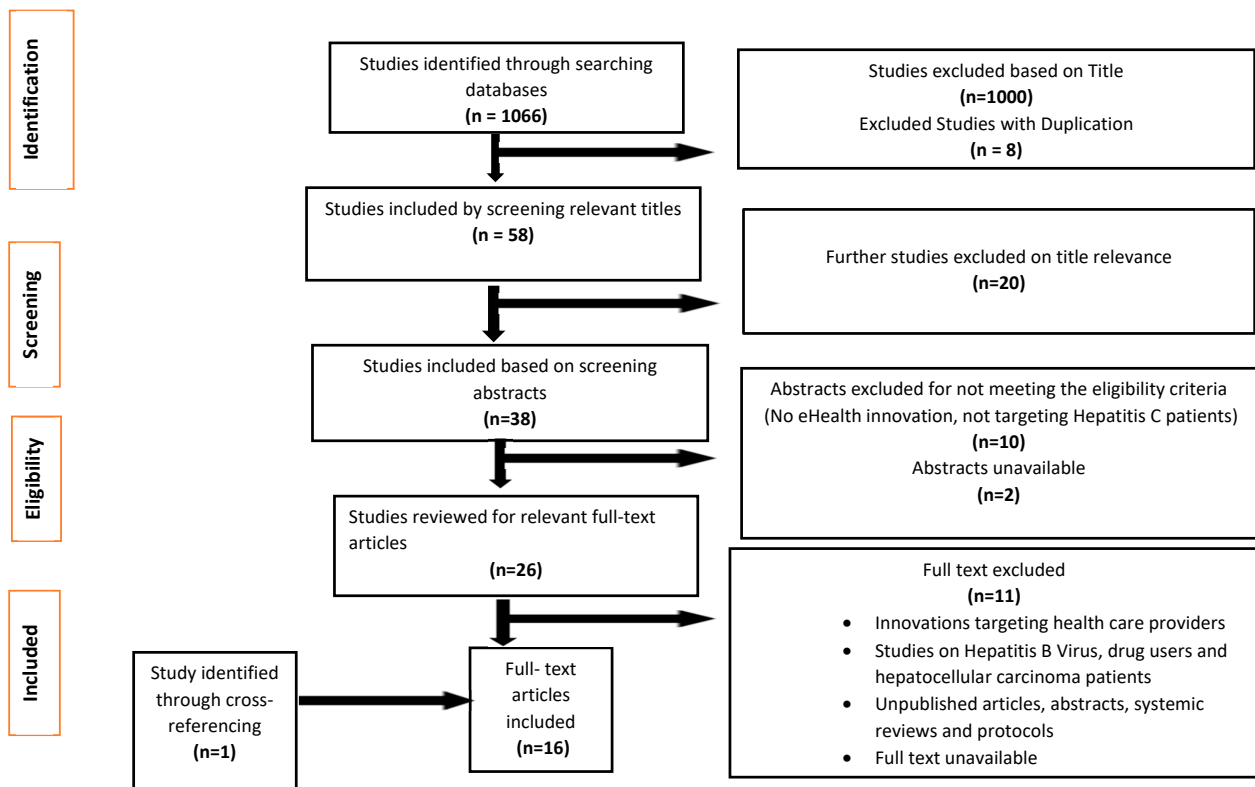


Figure 1. PRISMA Flow Diagram—Searching Databases for this review.

2.4. Assessment of Study Quality

The quality of the included studies was evaluated by standardized quality assessment tool, known as the mixed methods appraisal tool (MMAT). This tool was used to evaluate the methodological quality of all non-randomized studies. Overall, most studies included in this review were of good quality, indicating the significance of the methodological rigor. The purpose was to examine and gain insight into the rigor of existing research in this field. Two reviewers (NA, AK) independently assessed the quality of the included studies. In case of disagreement between the two, a third reviewer (AF) was consulted. Data on quality appraisal are provided in Table 2 for all the included studies.

Table 2. Quality appraisal. Result of quality appraisal, the mixed methods appraisal tool (MMAT).

Quantitative Non-Randomized Studies	Quality Assessment Components Using MMAT				Total
	Are Participants Recruited in a Way That Minimizes Selection Bias?	Are Measurements Appropriate Regarding the Exposure or Intervention and Outcomes?	In the Groups Being Compared, are the Participants Comparable, or Do Researchers Take into Account?	Are There Complete Outcome Data (80% or Above), an Acceptable Response Rate (60% or Above), or An Acceptable Follow-Up Rate for Cohort Studies?	
Morey et al., 2019	0	1	1	1	3
Mohsen et al., 2019	1	1	1	1	4
Cooper et al., 2018	1	1	1	1	4
Yoo et al., 2017	0	1	1	1	3
Beste et al., 2017	1	1	1	1	4
Keogh et al., 2016	1	1	1	1	4
Chen et al., 2014	1	1	1	1	4
You et al., 2014	1	1	1	0	3
Rossaro et al., 2013	1	1	1	1	4
Nazareth et al., 2013	1	1	1	1	4
Rossaro et al., 2008	1	1	1	0	3
Jiménez-Galán et al., 2019	1	1	1	1	4
Schulz et al., 2018	1	1	1	1	4
Case et al., 2019	1	1	1	1	4
Arora et al., 2011	1	1	1	1	4
Total = 15					
Mixed method Studies	Are the Sources of Data Relevant to Research Question?	Is the Data Analyzing Process Relevant to Address Research Question?	Is Appropriate Consideration Given to How Findings Relate to Context?	Is Appropriate Consideration Given to How Findings Relate to Researchers' Influence? (REFLEXIVITY)	Total
Lloyd et al., 2013	1	1	1	1	4
Total = 1					

3. Results

We included data from 16 selected studies that have utilized telehealth as an innovative mode of communication for the management of hepatitis C virus patients. Out of sixteen studies, ten studies were retrospective cohort studies [13–15,19,20,22,23,26,28,29], three were prospective cohort studies [18,24,30], one was a mixed methods study (both qualitative and quantitative components) [21] and the remaining two were observational–descriptive studies [25,27]. The final selected studies were divided into four main categories which included improving treatment rates via utilizing telehealth services, satisfaction with telehealth services, disease management and health promotion, and similarity between telehealth and traditional modalities.

3.1. Improving Treatment Rates via Utilizing Telehealth Services

The studies classified under this domain have shown that utilization of telehealth services has significantly improved treatment rates among HCV patients [14,18,22,24]. A cohort study was done in Taiwan to examine the effectiveness of “telecare” for the treatment of hepatitis C patients. A total of 298 patients randomly chose to be part of the following two groups: in group 1, nurse consultation was offered at an outpatient clinic, while in group 2, a 24 h telephone consultation service was offered through a health communication center. All patients were managed with standard therapy and followed up for 72 weeks. Patient compliance in group 1 was noted to be 88%, while it was 94.6% in group 2. In addition, the dropout rates were 12% and 5.4% in group 1 and group 2, respectively. Thus, it was found that this innovation has increased treatment efficacy by improving compliance rate and reducing dropout among the telehealth group as compared to the standard therapy [18]. A cohort database study on hepatitis C identified that half as many telemedicine (TM) patients commenced antiviral therapy than non-telemedicine patients (27.4% versus 53.8%, p -value < 0.001) [14]. This study concluded that the telemedicine program successfully motivated and retained a vulnerable population that suffered from multiple challenges during their HCV treatment [14]. Hence, telemedicine has tremendous potential to enhance patients’ drug adherence rates as compared to traditional modes of treatment. A study conducted on prisoners in northeast England revealed that 83% of the prisoners attended telemedicine services, 71% initiated an antiviral drug regimen, and 100% with known outcome attained sustained virological response. Thus, telemedicine clinics can significantly increase management (testing, diagnosis, and treatment) of HCV among prisoners [22]. Another study showed that 6431 patients who were under primary care providers participated in Veterans Affairs Extension for Community Health Outcomes (VA-ECHO) telemedicine sessions, whereas 32,322 patients did not have any video conferencing (unexposed group). The exposed group had considerably higher rates of antiviral drug therapy as compared to the unexposed group (hazard ratio: 1.20; 95% CI: 1.10 to 1.32; p -value < 0.01). The rate of antiviral treatment initiated by the primary care provider was 21.4% among VA-ECHO teleconference group participants compared to 2.5% among unexposed group participants (p -value < 0.01) [24]. Thus, the telemedicine program was strongly associated with a higher rate of hepatitis C treatment initiation by primary care providers without raising the load of in-person specialty services.

3.2. Satisfaction with Telehealth Services

Different studies [22,25–27,29] have suggested that telehealth has a potential to enhance user satisfaction that ultimately increases patients’ engagement with the treatment. Overall, the satisfaction level highlighted in studies ranged from 70% to 80% [22,25–27]. These studies also put forth the feasibility of services in terms of saving patients’ time and cost [26,29]. This novel technology has enhanced the treatment opportunities for individuals suffering from hepatitis C, residing in hard to reach and underprivileged areas [25]. Moreover, patients preferred telemedicine services over the traditional mode of clinic visits due to the high level of privacy and confidentiality, along with the quality of care they received [29]. Additionally, the majority of the patients shared their readiness to utilize

telehealth services in the future, along with recommending this innovation to their families and friends [25,26].

3.3. Disease Management and Health Promotion

Health promotion and disease prevention are fundamental to manage disease and control HCV-related outbreaks in a timely manner. Utilizing telehealth services enabled earlier access to healthcare services that can inhibit disease complications at a rapid rate. Studies showed that the feasibility, efficacy, and safety of telemedicine have resulted in an increased uptake of HCV treatments among patients, which contributed towards reducing the disease burden, particularly in remote and underprivileged areas that suffer additional challenges such as poverty and fewer medical experts, centers, and other basic resources [15,21,23,28]. A study done by Keogh et al. in 2016 also showed a positive impact, as there was a more than four-fold increment in consultations, which reflects that telehealth increased patient engagement, decreased loss to follow-up, and reduced delay in seeking treatment among HCV patients [19]. A retrospective analysis identified that almost 95% of patients did not require a follow-up visit due to optimization of task-shifting via utilizing eHealth clinics [13]. A cohort of patients undergoing telemedicine consultations at the Peach Tree Clinic in rural Northern California found that 37% had cirrhosis and 64% of them had never received any treatment or undergone any treatment regimen. This study indicated telemedicine as an innovative tool for the timely screening and treatment of hepatitis C patients, especially for rural communities that suffer from multiple barriers, including higher poverty rates and fewer medical experts, and resources [15]. Similarly, another study also highlighted that 108 (28%) patients initiated treatment and 85 (79%) were triaged for professional assessment through telemedicine [21]. This advancement in technology offered direct and secure communication among healthcare providers and directed earlier and proper treatment among patients by healthcare experts [13,15]. A retrospective cohort study done by Mohsen et al. in 2019 also assessed if Project ECHO (PE) supported on-site clinicians treating HCV patients and compared the cohort of PE patients with tertiary liver clinic (TLC) patients. A total of 100 PE patients were discussed at a weekly teleconference scheduled for one to two hours and they were compared with 100 newly consulted HCV patients at the TLC via videoconferencing using the “hub and spoke” model. In both groups, almost 98% of the patients with virological follow-up who finished treatment and continued follow-up had a confirmed SVR. This helped in building professional expertise via modern technology rather than the traditional healthcare model, thus empowering healthcare professionals and strengthening the healthcare system [23]. Further, it was estimated that 86,720 km of patient travel were saved via using the telemedicine service [28]. Therefore, the expansion of a team-based telemedicine model can play a pivotal role in the successful utilization of a service and curb the transmission of hepatitis C virus [19].

3.4. Similarity between the Two Modalities, i.e., Telemedicine vs. Traditional Method

It was also evident from studies that no difference existed between telemedicine and traditional modes of treatment. The 2013 article by Rossaro et al. assessed treatment responses among 80 HCV patients treated with pegylated interferon and ribavirin through telemedicine (TM) consultation ($n = 40$) as compared to patients treated in hepatology clinics (HCs, $n = 40$). It was observed that patients in the TM group had more visits per week of therapy as compared to those in the HC group (TM: 0.61 vs. HC: 0.07; $p < 0.001$). However, no difference was observed in response to therapy (TM: 55% vs. HC: 43%; p -value = 0.36) [20]. Other studies compared the rates of SVR among HCV patients treated with telehealth as compared to gastroenterology clinics or face-to-face clinics [26,29,30]. It was noted that there was no significant difference in the sustained virologic response rate between the telehealth and face-to-face groups (73% versus 54%, respectively) [26]. Similarly, other studies also showed that SVR rates were insignificant between the two

treatment modalities [29,30]. Telehealth technologies have improved access to care for hepatitis C patients, particularly in remote areas [26,29,30].

4. Discussion

This review synthesized evidence on the use of telehealth technology in healthcare systems to manage patients with HCV. Telehealth can possibly reach the boundaries of patients by crossing the barriers of proximity [31]. The introduction of this novel modality in healthcare can bring ease in terms of the screening, diagnosis, and treatment of populations suffering from HCV. The role of telehealth identified in this review mainly focused on improving treatment rates via utilizing telehealth services, satisfaction with the telemedicine services, disease management and health promotion, and similarity between the two modalities.

Overall, the studies identified were done in the developed world but mostly targeted the HCV population residing in remote regions. A previous systematic review also recognized telehealth as the potential option for healthcare providers in terms of expanding their services in far-flung or hard to reach areas. This review also highlighted that telehealth provided direct linkage of patients' with expert healthcare providers that enabled the delivery of competent care and enhanced patients' expectations of the services [31].

Based on our analysis, most of the studies showed an improvement in treatment rates via utilizing telemedicine services compared to the usual mode of care [14,18,22,24]. Various studies suggested that HCV patients receiving telehealthcare attained similar sustained virologic response (SVR) rates as compared to the traditional mode of care [20,26,29,30]. A recent systematic review done by Gijssels et al. (2018) found a telehealth-supported program to be an effective medium in achieving similar cure rates for HCV patients as compared to face-to-face modes, particularly in rural areas where there is inadequate access to specialized care [32].

Telehealth technology is an acceptable modality among patients with chronic diseases [31]. Studies identified in this review showed that patients suffering from HCV preferred remote teleconsultation services because this high-quality service not only increased patients' access to and connection with specialized care but the ease of use saved patients' time and reduced their travel time and cost, which in turn helped to improve their outcomes and increased their acceptability and satisfaction level with the service [22,25–27,29].

Different studies also pointed out that telemedicine can contribute towards reducing the disease burden by providing timely treatment and care through healthcare professionals, preventing disease progression [13,15,19,21,23,28]. Previous studies also revealed that a lack of optimal care for HCV patients has been recognized as a fundamental barrier to initiating antiviral treatment [20,33]. Thus, the telehealth innovation allows prompt evaluation and treatment of individuals infected with HCV.

As with most reviews in the evolving field of telehealth and HCV, this review is limited by the difficulty in analyzing types of telehealth interventions across the included studies. In addition, fear of HCV-related stigma and discrimination, which hinders patients' access to healthcare settings/centers to initiate their treatment in a timely manner, is also not discussed [34]. Furthermore, no evidence exists on the role of telehealth utilization in developing countries, including Pakistan, where the prevalence rate is increasing at an alarming rate. Therefore, a more comprehensive understanding of the role of telehealth use for improving SVR rates among marginalized populations from developing countries is needed to refine the existing work with a larger body of evidence among diverse populations. Additionally, the role of governments is also required to incorporate this innovation into existing healthcare systems, particularly in the current pandemic where routine services for HCV patients are hampered. This call for policymakers to help legislation to catch up with this innovation by permitting further means of reimbursement for this modality will subsequently reduce the infection rate and improve public health at large. This review also recommends more clarification regarding the challenges of using this modality, including

privacy and confidentiality of patients, level of data security, and technological glitches that hamper the utilization of telehealth in managing HCV cases.

5. Conclusions

In a nutshell, the current evidence from the literature suggests that telemedicine is an effective and unique platform for the management of HCV patients, specifically those residing in remote and far-flung communities. This innovation improves patients' access to quality services, including distant care delivery and access to experts/specialists, thus enabling effective utilization of cost and time. Furthermore, with the current lockdown and social distancing rules, this innovation is highly significant to avoid delay in treatment. Integration of telehealth services in the existing healthcare models of both developed and developing countries is essential for early treatment of HCV. This in turn will reduce the existing HCV burden globally and play a key role in achieving the Sustainable Development Goals for HCV by the year 2030.

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