Govaresh/ Vol. 27, No.2, Summer 2022; 107-117.

Systematic Review

E-Health and Liver Cirrhosis Management: Before and After Covid-19 Outbreak

Zahra Asadzadeh [1], Elham Maserat [2], Azadeh Yazdanian [3], Zeinab Mohammadzadeh [1,*]

[1] Department of Health Informatics Technology, School of Management and Medical Informatics, Tabriz University of Medical Sciences, Tabriz, Iran

[2] Department of Medical Informatics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran

[3] Department of Medical Records and Health Informatics Technology, School of Allied Medical Sciences, Mazandaran University of Medical Sciences, Sari, Iran

ABSTRACT

Background:
Patients with cirrhosis need multi-dimensional care, coordinated care for their drugs, vaccinations and laboratory monitoring, scheduling of screening endoscopy, and imaging. However, with the advent of covid-19, these processes have been disrupted. The aim of this study was to review the applications of heath information technology in the management of liver cirrhosis before and after the outbreak of COVID-19.

Materials and Methods:
This review study was performed without time limitation by searching ProQuest, PubMed, Science Direct databases, and Google Scholar. The study steps include identifying research objectives and defining search strategy, identifying relevant research articles, selecting research articles, extracting data, summarizing, discussing, analyzing, and reporting results.

Results:
Finally, seven articles related to the pre-epidemic of COVID-19 and two post-epidemic articles were selected and analyzed in the related tables. The results show that the used technologies have benefits such as disease improvement, prevention of disease complications and providing routine services such as virtual visits, counseling, prescribing and reminding of drug doses and also effective potential in diseases management by maintaining social distancing and preventing the spread of infection in the period before and after the COVID-19 outbreak.

Conclusion:
The prevalence of COVID-19 epidemic is an opportunity to use information technology capabilities to manage patients with liver cirrhosis. Telehealth service providers consider that a favorable way to better management of liver cirrhosis, especially during an epidemic. IT-based approaches provide specialized liver and gastrointestinal services for all patients, regardless of distance.

Keywords: Liver Cirrhosis, Covid-19, E-health, Self-care

please cite this paper as:
Asadzadeh Z, Maserat E, Yazdanian A, Mohammadzadeh Z. E-Health and Liver Cirrhosis Management: Before and After Covid-19 Outbreak. *Govaresh* 2022;27:107-117.

Corresponding author:
Zeinab Mohammadzadeh , PhD
Assistant professor, Department of Health Informatics Technology, School of Management and Medical Informatics, Tabriz University of Medical Sciences, Tabriz, Iran
Tel: +984131775971
fax: +984131776002
E-mail: z.mohammadzadeh20@gmail.com

Received: 02 Dec. 2021
Revised: 29 Apr. 2022
Accepted: 30 Apr. 2022

INTRODUCTION

According to World Health Organization, chronic diseases are responsible for almost half of all deaths(1). Cirrhosis, as one of the chronic diseases, is the 11th leading cause of death worldwide, which causes 3.5% of the world's deaths. Egypt, Mongolia, and Moldova have the highest death rate due to cirrhosis. In Iran, cirrhosis is the first reason for hospitalization and the seventh reason for outpatients referring to medical centers(2).

Cirrhosis is a complicated chronic disease, so most untreated liver diseases lead to it(3). It involves fibrosis (scar tissue deposition) and nodule production in response

to liver damage. Finally, fibrosis leads to cirrhosis(4). In the third world and Iran, hepatitis B is the main cause of cirrhosis, while in the western world, alcohol abuse is the most common cause of cirrhosis(5,6). Also, the average mortality rate of liver cirrhosis due to hepatitis B is four times higher than hepatitis C in Iran(2).

Cirrhosis can have negative effects on patients and their families with complications such as recurrent bleeding, esophagus varicose, ascites, spontaneous bacterial peritonitis, bone diseases, fractures, hepatic encephalopathy, falling, and accident(7,8). Based on portal pressure degree and clinical symptoms, patients with liver cirrhosis are classified to compensated and uncompensated cirrhosis. Patients with cirrhosis need multi-dimensional care, coordinated care for their drugs, vaccinations and laboratory monitoring, scheduling of screening endoscopy, and imaging(9). But with the advent of COVID-19, these processes have been disrupted(8,10).

COVID-19 is created by a severe acute respiratory syndrome that primarily targets the human respiratory system and can cause acute respiratory disease, which is mostly accompanied by symptoms such as fatigue, fever, and dry cough(11-15). Currently, RT-PCR and chest computed tomography (CT) are reference standards for the definitive diagnosis of COVID-19(13,14). COVID-19 is a global problem not only for rapid transfer from one human to others but also because of the consequences on social life, economy, and infrastructures(11,12). Patients with end-stage liver disease need serious care due to concomitant diseases, especially infection(10). Furthermore, the current pandemic requires to the unusual allocation of health care which may adversely affect the care of patients with chronic liver disease(11).

Management and provision of patients with advanced liver disease are often performed in larger centers. But now, these centers focus on the treatment of patients with COVID-19, so the risk of COVID-19 occurrence increases for these patients. Furthermore, hospital staff is facing challenges such as long working hours and reduction of staff due to COVID-19 quarantine. Thus, different factors should consider for vulnerable patients(16).

Telemedicine is an ever-evolving method for providing remote care through information & communication technology (ICT). Rapid advancement and availability of technology, along with expanded use of the internet and smartphones, are strong motive forces for telemedicine development in recent years(17).

The shortage of hepatologists and their deployment in densely populated areas or transplant centers are driving factors for telemedicine applications(18, 19). Therefore, the challenges facing hepatologists are telemedicine promotion in outpatient settings, prioritization of outpatients, prevention of virus spreading to patients and providers, and keeping standard care for patients in emergency situations(1, 20).

Recently published studies in telemedicine and e-health journals have shown telemedicine importance during COVID- 19 pandemic in Italy(21). The results of studies show that innovation of telehealth and mobile health can lead to promoting the quality of care for patients with liver diseases and expanding hepatologists' capability(9,22). Many studies have confirmed the usefulness of health information technology for the management of infectious diseases. The aim of this study was to review the applications of heath information technology in the management of liver cirrhosis before and after the outbreak of COVID-19.

MATERIALS AND METHODS

Information resources and search strategy

A systematic search of databases was performed by the authors without any restrictions on the time of article publication. Articles that included information about liver cirrhosis, self-care, coronavirus (COVID-19), and different technologies related to liver management were systematically searched in ProQuest, PubMed, and Science Direct databases. Also, articles that included technologies related to self-care and liver cirrhosis complication management, such as ascites, recurrent variceal hemorrhage, spontaneous bacterial peritonitis and so on, were searched. There are different types of cirrhosis, such as biliary cirrhosis, liver cirrhosis, alcohol cirrhosis, cryptogenic cirrhosis, and so on; our goal focused on liver cirrhosis. For more screening, a manual search of articles was done in the google scholar database in addition to the systematic search. Keywords were selected based on Mesh and were compounded with Boolean operators AND & OR, which included:

(Cirrhosis OR hepatomegaly) AND (Information

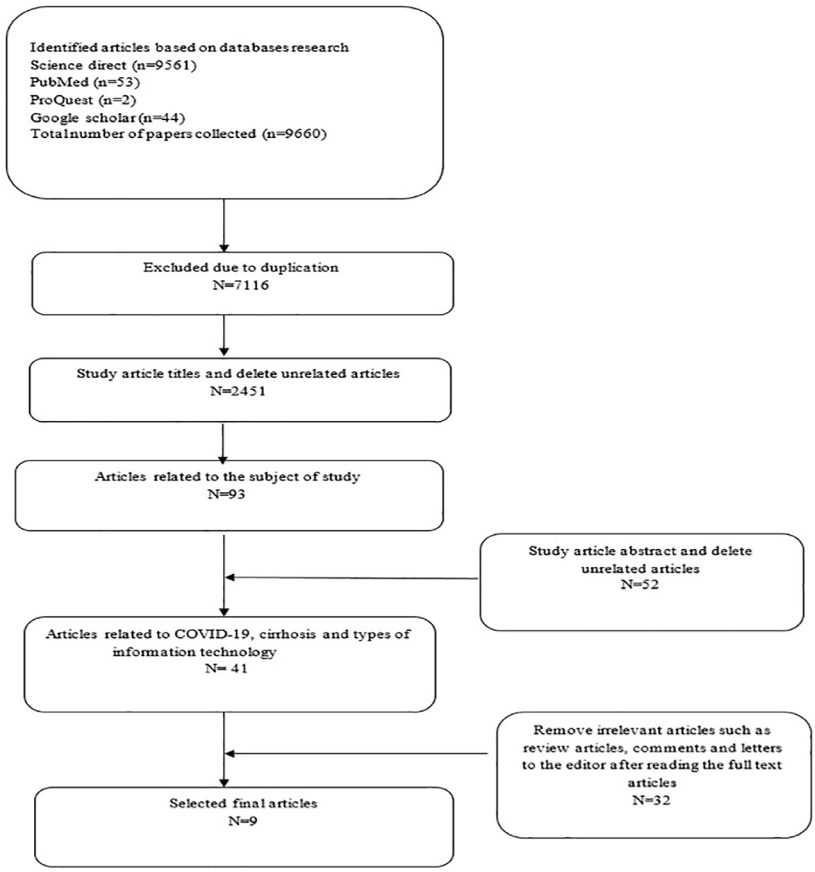

Fig.1: A summary of the search strategy for the selection and screening of the articles

Technology OR Computer OR Mobile app OR Telehealth OR ehealth OR Telemedicine OR Web site OR Portal OR software) AND (Self-care OR Self management) AND (COVID-19 OR Coronavirus 2019 OR SARS-CoV-2 infection OR COVID-19 pandemic OR Coronavirus disease 2019 OR COVID-19 virus infection)

The word liver fibrosis was omitted during the search because irreversible fibrosis leads to liver cirrhosis, and if treated, the disease will not progress to cirrhosis.

Inclusion criteria

All kinds of articles related to coronavirus (COVID-19), liver cirrhosis, and its complications, along with self-care processes related to a variety of technologies, were selected and analyzed.

Exclusion criteria

Articles that did not have one of the subjects, such as the self-care, coronavirus, liver cirrhosis and associated complications, and a variety of technologies, were excluded after searching the databases. Also, other exclusion criteria were:

- Suggested one-page studies, letters to the editor, and articles
- Review articles
- Articles were not well executed
- Articles did not introduce a new system and only examined other systems
- Lack of access to full-text articles

Search strategy

In the first step, the articles were searched in Google Scholar, ProQuest, PubMed, and Science Direct databases, and the extracted articles were saved in excel format. Initially, 9,660 papers were obtained. In the

Table 1: Articles on various technologies for the management of liver cirrhosis or its complications

NO	Author/ Year	Setting/ population	Purpose of intervention	Type of intervention	Method/time	Sample size	Results
1	Thomson et al.(2015) (23)	USA	To investigate whether IVR* monitoring can predict hospitalization and mortality in cirrhosis.	IVR calls	prospective cohort study/ range 7–874 days	79	These results suggest IVR calls can be used to predict hospitalization in decompensation cirrhosis.
2	Bajaj et al.(2013) (24)	USA	To validate the use of this Stroop smartphone app for the screening of cognitive dysfunction in cirrhosis.	Smartphone Application	Cohort /	134	Stroop smartphone app is a short, valid, and reliable tool for screening MHE*
3	Konjeti et al.(2019) (25)	USA	To compare transplant evaluation outcomes between referrals triaged through SCAN-ECHO with the ones referred directly	(Specialty Access Network-Extension of Community Healthcare Outcome) Virtual consultation	Between 1 August 2012 and 30 September 2016	190	There was no difference in the distance of patients from the transplant center between the two groups.
4	Su et al.(2018) (26)	USA	To evaluate the effect of the Echo Scan Program on survival and mortality rate	(Specialty Access Network-Extension of Community Healthcare Outcome) Virtual visit	Cohort/ from 1 June 2011 to 31 March 2015.	513	If the echo scan is used, the survival rate of patients is significantly increased and is similar to that in the office. The risk of mortality is reduced in patients with or without progression of fibrosis.
5	Ha P et al. (2018) (27)	Australia	Designing, developing, and implementing a remote monitoring system (RMS) for outpatients with cirrhotic ascites.	Smartphone application – Web app	Prospective non-randomisedtrial / 6W	27	Designed an internet-enabled RMS for outpatients with cirrhotic ascites that could be used as an adjunct to existing outpatient services.
6	Valizadeh et al.(2019) (28)	Iran	Develop a self-care smartphone application for cirrhotic patients	Smartphone application	Methodological study / 1Y	74	Smartphone applications can be useful tools for cirrhotic patients to perform self-care without the direct presence of the nurse
7	Ganapathy et al.(2017) (29)	USA	Define the feasibility of using the Patient Buddy App and its impact on 30-day readmissions by engaging and educating cirrhotic inpatients and caregivers in a pilot study.	Application	Proof-of-concept study / 30 D	40 patients and 40 caregivers	The use of Patient Buddy is feasible in recently discharged patients with cirrhosis and their caregivers.

IVR: Interactive Voice Response
MHE: Minimal Hepatic Encephalopathy
RMS: Remote Monitoring System

Table 2: **Articles on various technologies for the management of liver cirrhosis during the coronavirus pandemic**

NO	Author/ Year	Setting/ population	Purpose of intervention	Type of intervention	Method/time	Sample size	Results
1	Serper et al.(2020)(30)	USA	The ultimate goal was to develop a scalable and sustainable program to improve patient access to subspecialty care for liver disease without compromising the quality of clinical care.	Telehepatology (telemedicine for advanced liver disease)	case study/ From March 2018 through December 2019,	67	Telehepatology whereby providing care to patients with complex advanced liver disease is feasible, acceptable, efficient, and does not compromise clinical care.
2	Fix OK et l.(2020(31)	USA	- Providing information about Covid-19 - Providing recommendations and clinical policies to prevent the Covid -19 in chronic liver patients and providers.	Telehealth	Original	-	The use of telemedicine and mobile phones leads to better management of chronic liver disease in the COVID-19 pandemic

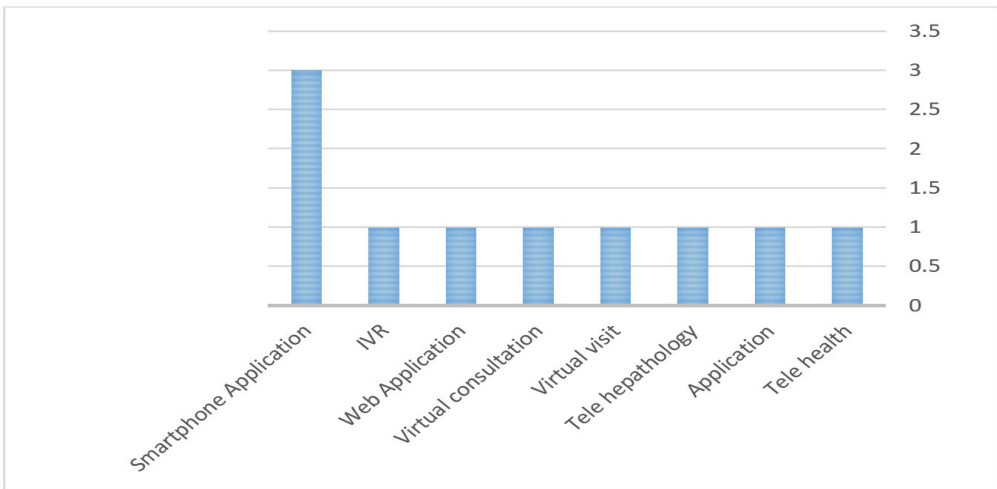

Fig.2: **Frequency of used technologies in the management of liver cirrhosis before and after the Covid-19 outbreak.**

second step, 7,116 duplicated ones were removed after transferring and saving articles on EndNote. In the third step, the titles of the remaining articles were reviewed, and 2,451 unrelated articles were removed. In the fourth step, the abstract and summary of the remaining articles were studied, and 52 articles were deleted. In the next step, 41 full-text articles were studied, and 32 articles were removed at this stage. At last, 10 articles related to the search topic were identified and were used for data extraction. Among these 10 articles, seven articles were related to cirrhosis management with information technology approaches in the pre COVID-19 pandemic period, and two articles were related to cirrhosis management with information technology approaches during the outbreak. A summary of the search strategy for the selection and screening of the articles is shown

in figure 1.

Data extraction

Initially, the titles of all articles in the mentioned databases were searched individually, and related articles were saved in EndNote and excel. Duplicated articles were removed in excel software. After saving the titles of the articles in the EndNote. The initial extraction of data and articles was performed with the aim of removing unrelated articles from the title and abstract. After removing duplicated articles, all articles were reviewed separately by three researchers. In this way, first, the titles of articles and then abstracts were examined, and irrelevant articles were deleted. In the next step, full-text articles were studied that were relevant articles. If there was any doubt in the selection of some articles, the article in question was reviewed by the team members to decide on its selection. After evaluating the full-text articles, all articles, even if they did not meet one of the inclusion criteria, were excluded. The information of related articles is summarized in table 1 and 2, which include the following items: Author of the article, year of article publication, the environment in which the study was conducted, the purpose of the performed intervention, the kind of performed intervention, the kind of performed study, the number of samples and article results.

RESULTS

The following tables show the findings of our studies, which include the components of authors' names, year of publication, country of study, the purpose of the intervention, type of intervention, method of intervention, number of sample people, and results. The findings are presented in two tables. Table 1 is related to the studies before COVID-19 outbreak (seven related articles), and table 2 is related to the studies following the COVID-19 outbreak (Two related articles).

The present study surveyed the role of various technologies in liver cirrhosis management before and after coronavirus pandemic. Almost all technologies have been used to manage this disease. For example, websites and smartphone applications are used for liver ascites management, as a liver cirrhosis complication. Figure 2 shows the frequency of technologies used in the studies.

The results show that the used technologies have benefits such as disease improvement, prevention of disease complications, and providing routine services such as virtual visits, counseling, prescribing and reminding of drug doses and also effective potential in diseases management by maintaining social distance and preventing the spread of infection in the period before and after the COVID-19 outbreak.

DISCUSSION

The aim of this study was to evaluate the care of liver cirrhotic patients before and after the coronavirus. Cirrhosis is one of the diseases that requires specialized multifaceted care with the cooperation of service providers at all levels of health. This disease imposes a financial and care burden on patients, medical centers, and care providers with multiple complications that can lead to hepatocellular carcinoma and, ultimately, liver transplantation(32-34). Because of the COVID-19 effects on the routine care of liver cirrhosis, new tools and approaches such as tele-health should be using(31,35,36).

This article examines the various technologies for the management of liver cirrhosis, while other articles reviewed the existing technologies for the management of various liver diseases. For example, Matthew Johnson and colleagues reviewed existing technologies for the management of liver cirrhosis, hepatitis C, and liver transplantation. Their finding showed that telehealth interventions were a logical solution for screening improvement, providing quality care, and reducing costs(8). Cindy and colleagues examined technology interventions in the field of cirrhosis, hepatocellular carcinoma, liver transplantation, and hepatitis C. Their findings showed that a combination of technologies with healthcare provided services in remote areas(37).

With the beginning of COVID-19 and the emphasis on maintaining social and physical distance(38-40), routine clinical procedures and alternative therapies for liver cirrhosis are abolished, and care is limited to essential care. So for a long time, the lack of such care (for example, increased varicose bleeding) caused serious problems for patients with liver cirrhosis(41,42).

According to studies, telehealth improves access to primary care for chronic patients at the time of the COVID-19 and prevents the management disorders of chronic diseases and is required as a default for

primary care(43). In fact, telehealth is an intelligent intervention in the management of chronic diseases that saves time for providers and service recipients, accelerates the decisions for medical departments, and is even used in clinical interventions by evidence-based medicine (such as preventing medication errors) so that the University of California has implemented telehealth in palliative care(13,43-45).

One of the major complications of liver cirrhosis is hepatic encephalopathy, which can lead to brain problems in patients. The Stroop Smartphone Application is used to screen for minimal hepatic encephalopathy in patients with liver cirrhosis. In this software, cognitive dysfunction is investigated by performing ICT, BDT, and DST tests, and the extent of patient's encephalopathy is diagnosed and treated to prevent disease progression and better disease management. The software was used to manage patients with liver cirrhosis before the outbreak of coronavirus by various institutions and academic centers(24).

Monitoring System is another technology that can be used in medicine to manage patients with liver cirrhosis and predict the hospitalization and death of such patients. In this method, by using IVR (interactive voice response calls), the main indicators of the patient's health status are reported instead of face-to-face visits, and the results of the study confirmed the effectiveness of this technology(23).

SCAN-ECHO, a successful project designed by the Richmond Veterans Administration, transfers ancillary knowledge to primary care physicians for liver cirrhosis management. Due to the fact that conducting a specialized consultation between the patient and the specialist requires a face-to-face visit, SCAN-ECHO conducts a training session, electronic consultations, telephone conferences, and an accurate triage of patients to provide quality care in deprived centers. The purpose of this technology was to provide expert advice through specialist physicians to first-line physicians. Therefore, the successful SCAN-ECHO program is one of the technologies that improves the quality of care, travel prevention, cost reduction, and patient satisfaction(25,26).

Ascites is another side effect of liver cirrhosis that can be diagnosed through endoscopy, and can lead to spontaneous bacterial peritonitis and infection if untreated. Phil Ha and colleagues examined Smartphone application technology for ascites management. This technology is available as a web application, and during training sessions by nurses, it asks patients to enter information such as abdominal pain, fever, abdominal irritation, peripheral edema, and jaundice into the software. If there is a warning, nurses will contact the patient directly, and by performing related interventions and consultations, they will be able to prevent the patient's hospitalization and manage ascites cirrhosis(27).

During the COVID-19 pandemic, a variety of technologies have been used to manage liver cirrhosis. The role of telehealth is more than clinical visits in this period and allows remote monitoring by the care team, centralized training, caregiver support, initial interventions, and cost reduction(1,2). Telehepatology is another technology for patients with advanced liver diseases so that it facilitates the care of this vulnerable population at this critical time(13). Also, during the COVID-19 pandemic, home monitoring measures have been taken for liver transplant recipients through telehealth in the Asia-Pacific region(14).

All health care professionals can use information and communication technology (ICT) to exchange valid information for diagnosis, treatment, prevention, research, and evaluation. In fact, telehealth can provide high-quality services, increasing access to care, self-awareness, and saving time and money(46).

Despite the potential of telemedicine to improve access to optimal care, there are barriers to its implementation due to insufficient repayment, barriers to intergovernmental licensing, lack of infrastructure, and resistance to change(11). In many US states, the use of telemedicine has been restricted for these reasons, which was temporarily eliminated during the COVID-19 outbreaks. Also, inadequate infrastructure and trained health care personnel in liver disease are important issues for telehealth in the Asia-Pacific region(14).

Therefore, it can be concluded that the capacity of telemedicine before the COVID-19 pandemic was restricted due to inadequate equipment, high training costs, limited insurance contracts, low repayment, and software limitation in the United States(38).During the global coronavirus pandemic, major telehealth groups around the world have temporarily removed barriers

to its implementations, such as allocating funds, eliminating some restrictions on Medicare Telehealth, signing the Supplementary Credit Allocation and Coronavirus Response Act, temporarily eliminating telemedicine/telehealth restrictions, and using HIPPA-compliant software for easy communication with patients. The private sector has also enforced telehealth payment restrictions due to the adoption of new laws.(1,11,38) According to conducted studies during the outbreak of COVID-19, the use of telehealth has increased as a successful strategy for patients.

CONCLUSION

Managing a chronic illness in the midst of an infectious disease pandemic is challenging. Because of liver complications, patients with liver cirrhosis need special care, especially if they are also susceptible to infection. The care and management of patients with liver cirrhosis are often performed in larger centers, which are important centers of COVID-19 now.

Therefore, groups of vulnerable patients should be protected from exposure to COVID-19. Therefore, to prevent the spread of COVID-19, maintaining social distance has been proposed, which has been officially implemented in several countries around the world(47).

Healthcare for patients with liver cirrhosis should be done according to the instructions, but with minimal exposure to medical staff, healthcare providers can evaluate their patients through telehealth and face-to-face communications in cyberspace. For healthcare professionals, these new technologies also provide an opportunity to improve patient care and reduce medical errors through rapid access to the latest evidence-based medical information.

As the results of studies have shown, clinical specialists have a smartphone and regularly use medical programs in their clinical practice. The current pandemic is not the first case experienced by government agencies and health care providers. While the potential benefits of telemedicine are well known, its use is limited. Telemedicine timely response to chronic disease management in emergencies requires skilled manpower capable of changing care delivery models. For telemedicine to be considered an effective item in disease management, it must become a routine and fixed part of the treatment system(41).

Due to the COVID-19 pandemic, telehealth has become an important method of providing clinical care because of key factors in slowing virus transmission, maintaining social distance, and reducing person-to-person contact. Therefore, telemedicine has always had the potential to improve access to health care and reduce costs.

Although telemedicine technology is inexpensive, it is widely available and accepted by patients and providers. The prevalence of COVID-19 provides an opportunity not only to use this technology in crisis but also to improve safety and productivity for primary and specialized care. To achieve this goal, it is necessary to remove the obstacles to telehealth implementation at any time.

According to the research reviewed in this study, with the advent of COVID-19, the use of various technologies to manage liver cirrhosis has increased and has become a powerful tool in patient management. Telehealth has made a significant contribution to the necessary interventions and active preventive care of patients with liver cirrhosis through the possibility of remote training and monitoring by the care team and, of course, with minimal exposure to patients.

In fact, telehealth, as a successful strategy to manage patients with liver cirrhosis, was located at the forefront of clinical care during the COVID-19 pandemic.

According to the studies, the application of technology in the management of patients with liver cirrhosis includes the following:

Provide routine care to patients.

Providing specialized liver and gastrointestinal services for all patients, regardless of distance

Monitoring and preventing disease progression and disease complications

Save time and money for patients, medical centers, and care providers.

Preventing the readmission of patients in medical centers

Reducing the workload of health care providers and saving available resources

Predicting patient mortality

-Screening patients for liver transplantation

-Reducing the risk of COVID-19 disease

Participation of patients and their families in disease management (self-care).

For telehealth to be sustainable in the future, we

must advocate for legal reform at the federal and state levels to support many of the current exemptions that allow telemedicine services. These changes must be considered economically sustainable and implemented to maximize patient safety and privacy. While the world has been devastated by COVID-19, the realization of telehealth is a desirable step to improve the current state of the world.

Ethics approval and consent to participate

-The study was approved by the Ethics Committee of Tabriz University of Medical Sciences (TUoMS) (IR.TBZMED.REC.1399.169).

-All methods were carried out in accordance with relevant guidelines and regulations.

-Informed consent was obtained from all participants involved in the study.

Consent for publication

Not applicable

SupplementaryMaterial:

Thereis no supplementary file.

Availability of data and materials:

All data generated or analyzed during this study are included in this published article

Competing interests:

No conflict of interest declared.

Authors' contributions:

All authors contribute in all in all stages of the study. They read and approved the final manuscript.

ACKNOWLEDGMENTS

Not applicable

REFERENCES

1. Murray CJ, Lopez AD. Evidence-based health policy—lessons from the Global Burden of Disease Study. Science. 1996;274(5288):740-3.
2. Rezaei N, Asadi-Lari M, Sheidaei A, Khademi S, Gohari K, Delavari F, et al. Liver cirrhosis mortality at national and provincial levels in Iran between 1990 and 2015: A meta regression analysis. Plos One. 2019;14(1):e0198449.
3. Ganji A, Malekzadeh F, Safavi M, Nassri-Moghaddam S, Nourie M, Merat S, et al. Digestive and liver disease statistics in Iran. Middle East J Dig Dis. 2009;1(2):56-62.
4. Volk ML, Fisher N, Fontana RJ. Patient knowledge about disease self-management in cirrhosis. Am J Gastroenterol. 2013;108(3):1-10.
5. Werner KT, Perez ST. Role of nurse practitioners in the management of cirrhotic patients. The JNP. 2012;8(10):816-21.
6. Lim Y-S, Kim WR. The global impact of hepatic fibrosis and end-stage liver disease. Clin Liver Dis. 2008;12(4):733-46.
7. Younossi Z, Guyatt G, Kiwi M, Boparai N, King D. Development of a disease specific questionnaire to measure health related quality of life in patients with chronic liver disease. Gut. 1999;45(2):295-300.
8. Stotts MJ, Grischkan JA, Khungar V. Improving cirrhosis care: The potential for telemedicine and mobile health technologies. World J Gastroenterol. 2019;25(29):3849-56.
9. Serper M, Volk ML. Current and future applications of telemedicine to optimize the delivery of care in chronic liver disease. Clin Gastroenterol Hepatol. 2018;16(2):157-161.
10. Boettler T, Newsome PN, Mondelli MU, Maticic M, Cordero E, Cornberg M, et al. Care of patients with liver disease during the COVID-19 pandemic: EASL-ESCMID position paper. JHEP Rep. 2020;2(3):100113.
11. Saberifiroozi M. Improving quality of care in patients with liver cirrhosis. Middle East J Dig Dis. 2017;9(4):189-200.
12. Lauridsen MM, Thacker LR, White MB, Unser A, Sterling RK, Stravitz RT, et al. In patients with cirrhosis, driving simulator performance is associated with real-life driving. Clin Gastroenterol Hepatol. 2016;14(5):747-52.
13. Thomson MJ, Lok AS, Tapper EB. Optimizing medication management for patients with cirrhosis: evidence-based strategies and their outcomes. Liver Int. 2018;38(11):1882-90.
14. Bajaj JS, Saeian K, Hafeezullah M, Hoffmann RG, Hammeke TA. Patients with minimal hepatic encephalopathy have poor insight into their driving skills. Clin Gastroenterol Hepatol. 2008;6(10):1135-9.
15. Aghanwa HS, Ndububa D. Specific psychiatric morbidity in liver cirrhosis in a Nigerian general hospital setting. Gen. Hosp. Psychiatry. 2002;24(6):436-41.
16. Su H-Y, Hsu Y-C. Patients with cirrhosis during the COVID-19 pandemic: Current evidence and future perspectives. World J Clin Cases. 2021;9(13):2951-2968.

17. Kanwal F, Gralnek IM, Hays RD, Zeringue A, Durazo F, Han SB, et al. Health-related quality of life predicts mortality in patients with advanced chronic liver disease. Clin Gastroenterol Hepatol. 2009;7(7):793-9.

18. Tapper EB, Asrani SK. The COVID-19 pandemic will have a long-lasting impact on the quality of cirrhosis care. J Hepatol. 2020;73(2):441-5.

19. Xu X, Yu C, Qu J, Zhang L, Jiang S, Huang D, et al. Imaging and clinical features of patients with 2019 novel coronavirus SARS-CoV-2. Eur J Nucl Med Mol Imaging. 2020;47(5):1275-1280.

20. Cooper CL, Hatashita H, Corsi DJ, Parmar P, Corrin R, Garber G. Direct-acting antiviral therapy outcomes in Canadian chronic hepatitis C telemedicine patients. Ann Hepatol. 2017;16(6):874-80.

21. Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. J Autoimmun. 2020;109:102433.

22. Doraiswamy S, Abraham A, Mamtani R, Cheema S. Use of telehealth during the COVID-19 pandemic: scoping review. J Med Internet Res. 2020;22(12):e24087.

23. Thomson M, Volk M, Kim HM, Piette JD. An automated telephone monitoring system to identify patients with cirrhosis at risk of re-hospitalization. Dig Dis Sci. 2015;60(12):3563-9.

24. Bajaj JS, Thacker LR, Heuman DM, Fuchs M, Sterling RK, Sanyal AJ, et al. The Stroop smartphone application is a short and valid method to screen for minimal hepatic encephalopathy. Hepatology. 2013;58(3):1122-32.

25. Konjeti VR, Heuman D, Bajaj JS, Gilles H, Fuchs M, Tarkington P, et al. Telehealth-based evaluation identifies patients who are not candidates for liver transplantation. Clin Gastroenterol Hepatol. 2019;17(1):207-9. e1.

26. Su GL, Glass L, Tapper EB, Van T, Waljee AK, Sales AE. Virtual Consultations Through the Veterans Administration SCAN-ECHO Project Improves Survival for Veterans With Liver Disease. Hepatology. 2018;68(6):2317-24.

27. Ha P, Warner S, O'Neil P, Anderson P, Sievert W. Development of a Smartphone Application to Enable Remote Monitoring in the Outpatient Management of Cirrhotic Ascites. J Int Soc Telemed Health. 2018;6:e7:1-9.

28. Valizadeh A, Aghebati N. Development and evaluation of a self-care smartphone application for cirrhotic patients. Evid Based Care J. 2019;9(3):32-40.

29. Ganapathy D, Acharya C, Lachar J, Patidar K, Sterling RK, White MB, et al. The patient buddy app can potentially prevent hepatic encephalopathy-related readmissions. Liver Int. 2017;37(12):1843-51.

30. Serper M, Cubell AW, Deleener ME, Casher TK, Rosenberg DJ, Whitebloom D, et al. Telemedicine in liver disease and beyond: can the COVID-19 crisis lead to action? Hepatology. 2020;72(2):723-8.

31. Fix OK, Serper M. Telemedicine and telehepatology during the COVID-19 pandemic. Clin Liver Dis. 2020;15(5):187.

32. Mellinger JL, Volk ML. Multidisciplinary management of patients with cirrhosis: a need for care coordination. Clin Gastroenterol Hepatol. 2013;11(3):217-23.

33. Powell EE, Skoien R, Rahman T, Clark PJ, O'Beirne J, Hartel G, et al. Increasing hospitalization rates for cirrhosis: overrepresentation of disadvantaged Australians. EClinicalMedicine. 2019 13;11:44-53.

34. Ioannou GN, Splan MF, Weiss NS, McDonald GB, Beretta L, Lee SP. Incidence and predictors of hepatocellular carcinoma in patients with cirrhosis. Clin Gastroenterol Hepatol. 2007;5(8):938-45. e4.

35. Arrese M. Telemedicine, COVID-19 and liver diseases: Revamping remote care initiatives in hepatology. Ann Hepatol. 2020;19(4):339-340.

36. Fix OK, Hameed B, Fontana RJ, Kwok RM, McGuire BM, Mulligan DC, et al. Clinical best practice advice for hepatology and liver transplant providers during the COVID-19 pandemic: AASLD expert panel consensus statement. Hepatology. 2020;72(1):287-304.

37. Piao C, Terrault NA, Sarkar S. Telemedicine: an evolving field in hepatology. Hepatol Commun . 2019;3(5):716-721.

38. Wong GL-H, Wong VW-S, Thompson A, Jia J, Hou J, Lesmana CRA, et al. Management of patients with liver derangement during the COVID-19 pandemic: an Asia-Pacific position statement. Lancet Gastroenterol Hepatol. 2020;5(8):776-87.

39. Giansanti D. The Italian fight against the COVID-19 pandemic in the second phase: The renewed opportunity of telemedicine. Telemed E-Health. 2020;26(11):1328-31.

40. Belingheri M, Paladino ME, Riva MA. COVID-19: Health prevention and control in non-healthcare settings. Oxford University Press UK; 2020. p. 82-3.

41. Wright JH, Caudill R. Remote treatment delivery in response to the COVID-19 pandemic. Psychother Psychosom. 2020;89(3):1.

42. Tapper EB, Asrani SK. COVID-19 pandemic will have a long-lasting impact on the quality of cirrhosis care. J Hepatol. 2020; 73(2):441-5.

43. Eccleston C, Blyth FM, Dear BF, Fisher EA, Keefe FJ, Lynch ME, et al. Managing patients with chronic pain during the COVID-19 outbreak: considerations for the rapid introduction of remotely supported (eHealth) pain management services. Pain. 2020;161(5):889.

44. Jahanshir A, Karimialavijeh E, Sheikh H, Vahedi M, Momeni M. Smartphones and medical applications in the emergency department daily practice. Emergency. 2017;5(1).

45. Calton B, Abedini N, Fratkin M. Telemedicine in the time of coronavirus. J Pain Symptom Manage. 2020;60(1):e12-e14.

46. Zu ZY, Di Jiang M, Xu PP, Chen W, Ni QQ, Lu GM, et al. Coronavirus disease 2019 (COVID-19): a perspective from China. Radiology. 2020;296(2):E15-E25.

47. Nouri S, Khoong EC, Lyles CR, Karliner L. Addressing equity in telemedicine for chronic disease management during the Covid-19 pandemic. NEJM Catalyst Innovations in Care Delivery. 2020;1(3).