

Analysis of Transmission of Hepatitis C Viruses: Dental vs. Surgical Procedures

Fawad Ahmad

Rural Health care center, Manthar, Dist. Rahim Yar Kha

Muhammad SAJJAD

Basic Health nit, Faisalabad

Muhammad Umair Akram

Rral health care center, Kacha khu, Dist. khanewal

Rabia Zulfiqar (✉ rabiazulfiqar@outlook.com)

King Edward Medical University <https://orcid.org/0000-0003-3897-2625>

Recep Kara

Istanbul Aydin University

Ahmad Talha Azam

Jinnah Hospital

Research

Keywords: Hepatitis C, Infectious disease transmission, Maxillofacial procedures, Oral surgical procedures, Sterilization

Posted Date: December 29th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-1097914/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Objectives: The primary purpose of the present study is to evaluate the cause of HCV transmission either by dental or surgical procedures in Pakistan. It will reveal the standards of current practices and knowledge of surgical instrument sterilization in Pakistan.

Methods: The contemporary study design was cross-sectional. A total of 7097 patients were included in the study that was the confirmed cases of Hepatitis C from four districts of Punjab, Pakistan, during the period of three years from Jul 1, 2018, to Jun 30, 2021. The ANN model simulates a discrete Pareto distribution; descriptive statistics were applied by using SPSS 23.

Results: In age distribution, most patients were aged 26-37 from the 2020- 2021 year of study with 45.6% age. The total mean \pm SD was $2.42 \pm .935$ with 0.000 *P*-values. Results show that high-risk variables are strongly associated with the surgical history, such as sector analysis (public and private) with 0.000 *P*-values. Analysis of these variables indicated that inquiry about surgical instruments sterilization and age groups (100%) were the most vital variable in the ANN model. Pareto distribution values of surgical procedures that are transmitting hepatitis C viruses more than the dental procedures.

Conclusion: Surgical procedures are high transmission source of hepatitis C viruses than dental procedures.

Clinical Significance: More care should be taken, and more severe sterilization measures should be taken to prevent the transmission of hepatitis C infection, especially in dental and general surgery procedures in Pakistan.

1. Introduction

1% of the total population is affected by the hepatitis C virus and enlisted as a significant global health issue. The principal transmitting agent for HCV is utilizing the infected needle, tattooing through used instruments, body piercing, and sharing the inter-nasal cocaine. The tattooing needs significant concerns as the HCV infection depends on the tattoo's area, size, and number [1]. The chances of the transmission of this disease through intercourse are less than 5 percent [2]. Pakistan was also present in countries with the highest HCV transmission risk factors [3]. The primary cause behind HCV spreading is a dental procedure, curettage, surgery, and dilation in Pakistan. Out of one hundred 90 million population of Pakistan, almost ten million people are infected with HCV. According to estimation, HCV seroprevalence and viremia-related prevalence among adults have been reported as 6.7% and 5.8% in Pakistan correspondingly [4, 5]. Another analysis points out that 2% of anesthetists received HCV infection due to accidental inoculation [6]. The presence of Hepatitis C Virus RNA in saliva and salivary glands of HCV-positive and sialadenitis patients has been reported by numerous studies [7]. So, HCV contaminated saliva in conjunction with the failure of adequately sterilized or reprocessed surgical and dental items may lead to HCV dissemination [8]. Statistically accurate data concerning HCV transmission for patients who have been undergone dental treatment is not available. Still, several studies indicate that

inappropriate utilization and cleaning of dental equipment may lead to HCV transmission. Evaluation of published studies marks HCV occurrence in 10 to 60% of individuals with a history of dental treatment [9]. So, numerous studies [10, 11] showing frequency elevation for HCV-infected surgical cases recommend that every patient be screened regularly, particularly those receiving any surgical or dental procedure. Thus, the study's primary purpose is to evaluate the cause of HCV transmission either by dental or surgical procedures, and such a study is novel from Pakistan and worldwide that will reveal the standards of current practices and knowledge of instrument sterilization.

2. Materials And Methods

A total of 7097 patients were included in the study that was the confirmed cases of Hepatitis C from four districts of Punjab, Pakistan, during the period of three years from Jul 1, 2018, to Jun 30, 2021. Included study settings were Sheikh Zayed Hospital, Rahim Yar Khan (n = 1349); Rural Health Care center, KachaKhu, District Khanewal (n= 1014); Basic Health Care Unit, Faisalabad (n = 846); and Outdoor Patient Department, Liver Clinic, Mayo Hospital Lahore (n = 3888). Three thousand one hundred ten patients were from the 2018-2019 year, 2385 patients were from 2019-2020, and 1602 patients were from 2020-2021. This study used a cross-sectional design. Different institutional review panels were approached to take the approval for the study. The article contains the entire plan for statistical analysis. This study was not funded by any organization as Pakistani does not provide this facility. This study interviewed all the patients who suffered from hepatitis C and was treated surgically. Inclusion and exclusion criteria have been presented in Table 1

The study was conducted by designing a questionnaire comprising of queries based upon transmission source of hepatitis C virus either by dental procedures or surgical procedures in Punjab, Pakistan. The English language was used to design the questionnaire and then translate it into the Urdu language for the convenience of some illiterate people. Data was collected after taking interviews from patients regarding the surgical history, and after taking interviews, patients were evaluated by their blood tests, e.g., ELISA and PCR. The following variables were studied; age, gender, study settings, surgical history (dental and general surgical), private and government sector analysis, patient's knowledge about sterilization, and inquiry about surgical instruments sterilization before going to operation theater for surgery. Before enrolling the patients for research, their consent has been taken. In the pandemic situation from the end of 2019 to 2021, we had continued to collect data with the SOPs (hand sanitization, mask-wearing, and social distancing). The situation has not affected our study.

2.1. Development of ANN Model

The ANN model was back-propagated and standard feed-forward and equipped with hidden layers, an output node, and input nodes. The feed-forward network layer contains the new tool, which is a multilayer perceptron network (MLP). The output layer is composed of neurons, while the input layer is made up of source nodes. The external work network is mainly linked through these two layers. There is an additional neuron layer, known as hidden neurons, as it is difficult to assess this layer directly. Through hidden

neurons can extract the primary input data features. The backpropagation algorithms are used for backward and forward trained MLPs. The backpropagation algorithms are efficiently executed and have satisfactory computational efficiency for linear complexity. The optimal learning proficiency can be attained by activating the neurons through anti-symmetric and non-symmetric functions[12,13]. In this research, selected factors (age, gender, study settings, year of study, sector analysis, patient's knowledge about sterilization, and inquiry about surgical instruments sterilization before going to operation theater for surgery) were served as the input layers neurons. One factor (dental procedures and general surgical procedures) was performed as the output layer neuron. ANN model developed on the study years and identical factors with the same standards. The selected factors (age, gender, study settings, surgical history (dental and general surgical), private and government sector analysis, patient's knowledge about sterilization, and inquiries about surgical instruments sterilization before going to Operation Theater for surgery) were served as the input layers neurons. One factor (years of study, e.g., 2018-2019, 2019-2020, and 2020- 2021) was served as the output layer neuron.

2.2.Simulating Discrete Pareto Distribution

Different phenomena like Pareto, Zipf, and power-law are used where small events are widespread, but the larger ones rarely occur. For instance, the occurrence of small earthquakes is quite common than the larger ones. Small cities are common than megacities. Some words are used frequently, like "and" and "the," while some words infrequently occur[14]. According to the Economists, in the 19th century, 20 percent of the Italians possessed the country's 80% wealth, which is observed through Wilfried Fritz Pareto. That is why it is also recognized as the 80/20 rule. According to the power law's example for transmission distribution, the hypothesis was consistent with the empirical data that the frequency of cases drives from the condensed power-law distribution in the form of $P(n) \sim n^{-\mu}$, $1 \leq n \leq n_{max}$ [15]. The histogram for the Pareto distribution was produced by utilizing the SPSS version 23, as shown in Fig. 3.

2.3.Statistical Analysis

Descriptive statistics were applied to determine the mean and standard deviation of age and gender distribution of patients of every study year. The following Table 1 and 2 were calculated the frequency and percentage in the target population who participated in the study. The Chi-square test was also applied with SPSS 23.0 software, and P values < 0.05 were considered statistically significant.

3. Results

3.1. Descriptive Analysis

7097 hepatitis C positive with surgical history patients who met the inclusion and exclusion criteria of the study were included. The age and gender distribution of patients are displayed in Table 2. Patients were divided into four age groups: 14-25 years, 26-37 years, 38-49 years, and >50 years. Most of the patients were shown in 26-37 years of age from the 2020- 2021 year of study with 45.6%age. The total mean \pm SD

was 2.42 ± 0.935 with $0.000P$ -values. In the gender distribution of patients from each study year, most of the patients were female with an overall 69.9%, while most of the females belonged to the 2020-2021 year with 77.5% and 30.1% were male have shown mean of 1.70 and standard deviation 0.459 as well $0.000P$ -values. The Chi-square test for the association of surgical history with other variables was applied. Results show that high-risk variables are strongly associated with the surgical history, such as sector analysis (public and private) with $0.000 P$ -values (Table 3).

3.2. Development of The Ann Model

The ANN model was developed based on considered variables such as age, gender, study settings, surgical history (dental and general surgical), private and government sector analysis, patient's knowledge about sterilization, and inquiry of about surgical instruments sterilization before going to Operation Theater for surgery (Fig. 1A), we used these as an input node. Analysis of these variables indicated that inquiry about surgical instruments sterilization was the most vital variable in the ANN model (100%); the following variables were private and government sector analysis (46%), age (38.8%), study setting (38.3%), gender (34%), patient's knowledge about surgical instrument sterilization (23.6%), and type of surgical history (18.9%) (Fig. 1B). The ANN model was developed based on considered variables such as age, gender, study settings, year of study, private and government sector analysis, patient's knowledge about sterilization, and inquiry of about surgical instruments sterilization before going to Operation Theater for surgery (Fig. 2A), we used these as an input node. Analysis of these variables indicated that age groups were the most vital variable in the ANN model (100%); the following variables were inquiry of surgical instruments' sterilization before going to operation theater for surgery (34%), year of study (18.6%), patient's knowledge about surgical instrument sterilization (11.9%), gender (9.8%), private and government sector analysis (6.7%), and study setting (5.6%) has illustrated in Fig. 2B below.

3.3. Simulating Discrete Pareto Distribution of The Source of Transmission of Hepatitis C Either by Dental Procedures or General Surgical Procedures

The determination of an appropriate Pareto distribution has explained the transmission source(dental procedures or general surgical procedures) with statistical analysis of every considered year (2018-2021). In Fig. 3, Pareto distribution values have been presented. According to this, surgical procedures transmit hepatitis C viruses more than dental procedures. In 2018-2019, the curve in general surgical procedures showed upward inclination with 34.4% and 6.4% in dental practices. In 2019-2020, the curve in available surgical procedures showed a further upward tendency with 28.5% and 4.2% in dental procedures. In 2020-2021, the curve in general surgical procedures showed an upward inclination with 19.7% and 2.8% in dental procedures.

4. Discussion

The current study was designed to evaluate the cause of transmission of the Hepatitis C virus either by dental or general surgical procedures. Our results affirm that Pakistan has one of the highest HCV infection levels in MENA[16, 17]worldwide [18, 19]. In Pakistan, Viral hepatitis is an alarming community-

based health problem. In our study, the prevalence of frequency of hepatitis C transmission in surgically treated patients is more with 26-37 years of age from the 2020- 2021 year of study with 45.6%age. The mean \pm SD was 2.42 ± 0.935 with $0.000P$ -values, and most of the patients were female with overall 69.9% while most of the females belonged to 2020-2021 years with 77.5% and 30.1% were male have shown mean of 1.70 and standard deviation 0.459 as well $0.000P$ -values. Compare the results of our study with Tanweer et al. (2017) study's results which demonstrated that the female percentage (53.2%) was higher than that of the male (46.8%). Among the different age groups, found the highest number of incidences of HCV in the age group of 31-40 years (26.6%). Results of this study supported our study. Hepatitis C virus transmission involves a variety of etiological risk factors that differ considerably across the globe. According to preceding literature, countless transmittable routes of HCV are prompted by injecting drug usage, difficult intercourse, unscreened blood transfusion, and manipulation methods of hemodialysis and perinatal care [2]. In our study, analysis of variables indicated that inquiry of about surgical instruments sterilization (100%), private and government sector analysis (46%), patient's knowledge about surgical instrument sterilization (23.6%), and type of surgical history (18.9%) were the most vital variable in ANN model. The considered risk factor was the poor sterilization of surgical instruments in both general and dental surgical procedures. In prevailing surgical procedures prevalence rate of hepatitis C was 34.4% and 6.4% in dental procedures in 2018-19, and it varies year to year like in 2019-2020; in general, surgical procedures patients have shown 28.5% and 4.2% in dental procedures; in 2020-2021, general surgical procedures show 19.7% and 2.8% in dental procedures of hepatitis C positive patients. It was in the patients who were getting hepatitis C after having any surgeries. Collectively, it was general surgical procedures responsible for transmitting hepatitis C. when we compare the results of our study with the study of Foad Ali Moosa et al.[20], we investigated that (45.5%) patients with a history of general surgical procedures were found positive carrier of HCV. His study was also supporting our findings. Idrees and Riazuddin highlighted that in Pakistan, approximately 70% of the cases were acquired in the hospitals via major/ minor surgery that is very common in Pakistan[21]. Farhana et al. demonstrated the overall observed mode of transmission in Pakistan from which major/minor surgery/dental procedures (10.62%) were presented as the second highest cause of transmission[22]. These previously conducted study findings support our study. In our study, 65.2% of patients had surgeries in the private sector, while 34.8% had surgeries in the public sector. Results show that high-risk variables are strongly associated with surgical histories, such as sector analysis (public and private) with $0.000P$ -values and 1240.4 chi-square value. Moreover, 93.6% of patients have little knowledge about the sterilization of surgical instruments, while only 6.4% have significant knowledge about sterilization with a 0.632 chi-square value and 0.237 p -values.

On the other hand, 0.7% of patients have enquired about sterilizing the surgical instruments before going to the operation theatre. Although multiple studies have been conducted on HCV prevalence and knowledge regarding risk factors in Pakistan, awareness about the sterilization of surgical instruments among the population is still inadequate. So, our study will highlight the poor and ignored sterilization process for both dental and general surgical procedures in Pakistan. The study's strengths are the large sample size, the novelty of the subject, and the importance of surgical instruments sterilization.

The constraints of the current study are limited literature for the study, and the sub-categorization and detail for dental care were not well defined. Moreover, the dental procedure previously taken by all the patients was different, which may skew the data as the HCV transmission risk was additional for the other patients. Like some patients are exposed to the HCV during root canal while some through tooth fillings. Similarly, we did not cover the type of general surgeries. Additionally, none of the articles has defined the poor sterilization of dental instruments to increase HCV transmission risk. Previous literature has discussed the transmission of hepatitis C during surgical procedures from patient to surgical staff. Still, no one is concerned that poorly sterilized instruments can transmit the hepatitis C virus to patients and surgeons. The current study has not covered all districts of Pakistan on a large scale. The recent research has not received any funds to cover all sections of Pakistan to know the patients' perspectives regarding the current topic.

5. Conclusion

The healthcare procedures are the primary causative agent behind the transmission and are highly prevalent in the risk population. The knowledge about the transmission in available data contains weaknesses and gaps. The private sector is also included in this drive to eliminate the HCV transmission risk by 2030. In this mission, awareness about instruments' sterilization in both surgical and dental procedures was ignored. It is concluded that general surgical procedures are a transmission source of hepatitis C viruses than dental procedures. Most people consider the private sector a safe and reliable place to get surgically treated. Still, our study findings demonstrated that the private sector is more likely to transmit hepatitis C through their surgical instruments. People do not become aware of dentistry and do not prefer to go to a dentist for any oral and dental surgery or care; when they get any difficulty regarding oral cavity, they go to the general physician or for any oral surgery like tooth extraction general surgeon. It is noteworthy that lack of awareness about the sterilization of instruments, people forgot to enquire about the surgical instrument sterilization from their surgeon before surgery.

5.1. Recommendations

Poor sterilization of surgical instruments in both general and dental surgical procedures should be considered a risk factor for transmission of hepatitis C viruses and develop a strategy to overcome the poor sterilization of instruments. In RCH, Kaha Khu, Khanewal, and BHU, Faisalabad does not match the race of districts working to prevent transmission of hepatitis C viruses. There are no such facilities available to implement the proper sterilization. In both districts, people do not know dental and general surgical instruments sterilization. Districts Rahim Yar Khan and Lahore have developed districts. Still, people also do not know dental procedures, and general surgical procedures can be a source of hepatitis C transmission. In these districts, awareness should give regarding this. There should be a check and balance of all private sector' surgical procedures and their sterilization protocol.

Like other developed programs (National blood transfusion authority, HIV AIDS, EPI, MNCH), the Government of Pakistan should start a program to people aware of surgical instruments sterilization, its

importance, consequences of lack of knowledge, and consequences after implementing sterilization. Also, educate the public that when going for a surgery, they must ensure from the surgeon about the sterilization of the instruments being used for their surgery. Adopting precautions measures during dental procedures is also necessary to reduce the risk of HCV transmission to patients. The preventive measures include sterilizations of dental instruments, hand hygiene, utilization of protective equipment like gloves and masks, appropriate handling of sharp, proper disposal of single-use medical equipment and injections, adequately utilizing reusable instruments, and environmental cleaning.

The active hospital management committee should regularly monitor the sanitary and sterilization practices performed by the hospital surgical staff before performing any dental or general surgery and held a meeting with the corresponding people. The sterilization of the instrument should carry out by the trained personnel. The dental health awareness program should be designed to spread awareness about dentistry, aiming to inform the general public that people should only go to the dental surgeon when they need any dental procedure but not to the general surgeon.

Abbreviations

HCV: Hepatitis C viruses HIV: Human Immunodeficiency Virus AIDS: Acquired Immunodeficiency Syndrome EPI: Expanded Programme on Immunization RHC: Rural Health Care BHU: Basic Health Unit ANN: Artificial Neural Network MLP: Multilayer Perceptron Network PCR: Polymerase Chain Reaction ELISA: Enzyme-Linked Immunoassay

Declarations

*Ethical Approval:*The study was approved by ethical research approval committee with the reference number 3918OMFSKEMU, 255/2020, and 04092021.

*Consent for publication:*This research work is not prior published in a conference or seminar. We hereby transfer, assign, or otherwise convey all copyright ownership, including any and all rights incidental there to, exclusively to the journal, in the event that such work is published by the journal.

*Availability of Data and Materials:*The data was collected from primary source and was not easily available and get through any other source.

*Conflict of Interest:*No

Funding Source: No

*Author's contribution:*All authors participated equally

Acknowledgment: I want to thank my teachers and institutes who allow us to collect data from there and guide us for publication. I acknowledge the effort of Mr. Syed Ali Haider, who has supported us in our statistics work and in our research journey of three years.

References

1. Y. Waheed, Transition from millennium development goals to sustainable development goals and hepatitis, *Pathog. Glob. Health.* 109 (2015). <https://doi.org/10.1080/20477724.2015.1126035>.
2. A.G. Lim, H. Qureshi, H. Mahmood, S. Hamid, C.F. Davies, A. Trickey, N. Glass, Q. Saeed, H. Fraser, J. GWalker, C. Mukandavire, M. Hickman, N.K. Martin, M.T. May, F. Averhoff, P. Vickerman, Curbing the hepatitis C virus epidemic in Pakistan: The impact of scaling up treatment and prevention for achieving elimination, *Int. J. Epidemiol.* 47 (2018). <https://doi.org/10.1093/IJE/DYX270>.
3. A.J. Khan, S.P. Luby, F. Fikree, A. Karim, S. Obaid, S. Dellawala, S. Mirza, T. Malik, S. Fisher-Hoch, J.B. McCormick, Unsafe injections and the transmission of hepatitis B and C in a periurban community in Pakistan, *Bull. World Health Organ.* 78 (2000). <https://doi.org/10.1590/S0042-96862000000800004>.
4. H. Mahmood, Risk Factors of Hepatitis C in Pakistan, *Gastroenterol. Hepatol. Open Access.* 7 (2017). <https://doi.org/10.15406/ghoa.2017.07.00259>.
5. P. K, S. D, D. S, et al, Hepatitis-A: Review on Current and Future Scenario, *J. Silico Vitro. Pharmacol.* 03 (2018). <https://doi.org/10.21767/2469-6692.100015>.
6. M. Umar, H.-T.-B. Khaar, T.S. Akhter, F. Aslam, S.I. Ahmad, R.M. Asghar, M. Khurram, T. Hussain, A. Salamat, A.A. Khan, Fazal-E-Hadi, Z.M. Minhas, H.A. Shah, J. Farooqui, A.A. Naqvi, A. Mohsin, Waseem-Ud-Din, S.I. Bhutta, S.U. Hasnain Syed, S. Qureshi, T. Adam, M. Uddin, G.-U.-N. Tayyab, N.U. Haq, A. Shoaib, S. Ambreen, A. Shahzad, N. Ikram, G. Nisar, M.M. Khan, M. Osama, Diagnosis, Management And Prevention Of Hepatitis C In Pakistan 2017., *J. Ayub Med. Coll. Abbottabad.* 28 (2016) S839–S882.
7. K. Javed, Z. Ishrat, N. Sultana, F. Naz, A. Anwar, Hepatitis C is more common than Hepatitis B among surgical patients and previous surgery is the most common risk factor, *Pakistan J. Med. Heal. Sci.* 1 (2009).
8. S.A. De Nishioka, T.W. Gyorkos, L. Joseph, J.P. Collet, J.D. Maclean, Tattooing and risk for transfusion-transmitted diseases: The role of the type, number and design of the tattoos, and the conditions in which they were performed, *Epidemiol. Infect.* 128 (2002). <https://doi.org/10.1017/s0950268801006094>.
9. J.J. Arrieta, E. Rodríguez-Inñigo, N. Ortiz-Movilla, J. Bartolomé, M. Pardo, F. Manzarbeitia, H. Oliva, D.M. Macías, V. Carreño, In situ detection of hepatitis C virus RNA in salivary glands, *Am. J. Pathol.* 158 (2001). [https://doi.org/10.1016/S0002-9440\(10\)63964-8](https://doi.org/10.1016/S0002-9440(10)63964-8).
10. T. Suzuki, K. Omata, T. Satoh, T. Miyasaka, C. Arai, M. Maeda, T. Matsuno, T. Miyamura, Quantitative detection of hepatitis C virus (HCV) RNA in saliva and gingival crevicular fluid of HCV-infected patients, *J. Clin. Microbiol.* 43 (2005). <https://doi.org/10.1128/JCM.43.9.4413-4417.2005>.
11. M.R. Memon, A.A. Shaikh, A.A. Soomro, S. Arshad, Q.A. Shah, Frequency of hepatitis B and C in patients undergoing elective surgery., *J. Ayub Med. Coll. Abbottabad.* 22 (2010).
12. P. Ström, K. Kartasalo, H. Olsson, L. Solorzano, B. Delahunt, D.M. Berney, D.G. Bostwick, A.J. Evans, D.J. Grignon, P.A. Humphrey, K.A. Iczkowski, J.G. Kench, G. Kristiansen, T.H. van der Kwast, K.R.M.

- Leite, J.K. McKenney, J. Oxley, C.C. Pan, H. Samaratunga, J.R. Srigley, H. Takahashi, T. Tsuzuki, M. Varma, M. Zhou, J. Lindberg, C. Lindskog, P. Ruusuvaori, C. Wählby, H. Grönberg, M. Rantalainen, L. Egevad, M. Eklund, Artificial intelligence for diagnosis and grading of prostate cancer in biopsies: a population-based, diagnostic study, *Lancet Oncol.* 21 (2020). [https://doi.org/10.1016/S1470-2045\(19\)30738-7](https://doi.org/10.1016/S1470-2045(19)30738-7).
13. X. Hu, H. Cammann, H.A. Meyer, K. Miller, K. Jung, C. Stephan, Artificial neural networks and prostate cancer-tools for diagnosis and management, *Nat. Rev. Urol.* 10 (2013). <https://doi.org/10.1038/nrurol.2013.9>.
14. L.A. Adamic, B.A. Huberman, Zipf's law and the Internet, *Glottometrics* 3. (2002) 143–150.
15. B. Blasius, Power-law distribution in the number of confirmed COVID-19 cases, *Chaos.* 30 (2020). <https://doi.org/10.1063/5.0013031>.
16. Y.A. Mohamoud, S. Riome, L.J. Abu-Raddad, Epidemiology of hepatitis C virus in the Arabian Gulf countries: Systematic review and meta-analysis of prevalence, *Int. J. Infect. Dis.* 46 (2016). <https://doi.org/10.1016/j.ijid.2016.03.012>.
17. K. Chaabna, S.P. Kouyoumjian, L.J. Abu-Raddad, Hepatitis C virus epidemiology in Djibouti, Somalia, Sudan, and Yemen: Systematic review and meta-analysis, *PLoS One.* 11 (2016). <https://doi.org/10.1371/journal.pone.0149966>.
18. K. Mohd Hanafiah, J. Groeger, A.D. Flaxman, S.T. Wiersma, Global epidemiology of hepatitis C virus infection: New estimates of age-specific antibody to HCV seroprevalence, *Hepatology.* 57 (2013). <https://doi.org/10.1002/hep.26141>.
19. M. Cornberg, H.A. Razavi, A. Alberti, E. Bernasconi, M. Buti, C. Cooper, O. Dalgard, J.F. Dillon, R. Flisiak, X. Forns, S. Frankova, A. Goldis, I. Goulis, W. Halota, B. Hunyady, M. Lagging, A. Largen, M. Makara, S. Manolakopoulos, P. Marcellin, R.T. Marinho, S. Pol, T. Poynard, M. Puoti, O. Sagalova, S. Sibbel, K. Simon, C. Wallace, K. Young, C. Yurdaydin, E. Zuckerman, F. Negro, S. Zeuzem, A systematic review of hepatitis C virus epidemiology in Europe, Canada and Israel, *Liver Int.* 31 (2011). <https://doi.org/10.1111/j.1478-3231.2011.02539.x>.
20. F.A. Moosa, B.A. Shaikh, M.S. Choudhry, B.F. Zuberi, F.W. Khan, N. Sultan, Frequency of hepatitis B and C in pre-operative patients for elective surgery, *J. Liaquat Univ. Med. Heal. Sci.* 8 (2009).
21. M. Idrees, S. Riazuddin, Frequency distribution of hepatitis C virus genotypes in different geographical regions of Pakistan and their possible routes of transmission, *BMC Infect. Dis.* 8 (2008). <https://doi.org/10.1186/1471-2334-8-69>.
22. F. Muzaffar, I. Hussain, T.S. Haroon, Hepatitis C: The dermatologic profile, *J. Pakistan Assoc. Dermatologists.* 18 (2008).

Tables

Table 1

Inclusion and exclusion criteria of the study

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> ✓ All tested positive for HCV after the results of ELISA and PCR ✓ Hepatitis C positive, surgically treated patients ✓ All patients previously treated with general surgery and dental surgery ✓ Patients above 14 years of age without gender discrimination ✓ Only Pakistani Were involved ✓ Of patients was not taking treatment but confirmed case of hepatitis C ✓ All patients who were entered or not entered in the follow-up phase ✓ Patients of any religion and any socioeconomic status 	<ul style="list-style-type: none"> ✓ Other causes of chronic hepatitis were excluded by appropriate serological testing and liver histology ✓ Patients with other risk factors except for dental surgery and general surgery ✓ Patients below 14 years of age ✓ Patients outside Pakistan were not involved ✓ Child-Pugh class showing advanced liver disease Child-Pugh Class C, and Patients having HBV-HCV co-infection ✓ Patients with associated medical conditions, e.g., diabetes, hypertension, and hepatitis ✓ Covid-19 positive patients

Table 2

Age and gender distribution of patients from every considered year

Age Groups	2018- 2019	2019- 2020	2020-2021	Total		
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	Mean ± SD	<i>P</i> -Value
Age, Years						
14- 25	573 (18.4)	331 (13.9)	231 (14.4)	1135 (16.0)	2.42 ±0.93	0.000
26- 37	1298 (41.7)	884 (37.1)	730 (45.6)	2912 (41.0)		
38-49	855 (27.5)	662 (27.8)	432 (27.0)	1949 (27.5)		
>50	384 (12.3)	508 (21.3)	209 (13.0)	1101 (15.5)		
Gender distribution						
Male	1215 (39.1)	563 (23.6)	361 (22.5)	2139 (30.1)	1.70 ± 0.45	0.000
Female	1895 (60.9)	1822 (76.4)	1241 (77.5)	4958 (69.9)		

Table 3

Results of frequency, percentage, and chi-square test for the association of surgical history with other variables

Parameters	Surgical history of patients		Total <i>n</i> (%)	Chi-Square	<i>P</i> -Value
	Dental Procedures (<i>n</i>)	General Surgical Procedures (<i>n</i>)			
Sector Analysis					
Private Sector	148	4507	4655 (65.2)	1240.4	0.000
Public Sector	813	1629	2472 (34.8)		
Patient's knowledge about surgical instrument sterilization					
Insignificant	905	5737	6642 (93.6)	0.632	0.237
Significant	56	399	455 (6.4)		
Inquiry about surgical instruments sterilization before going to operation theater for surgery					
Insignificant	947	6101	7048 (99.3)	9.521	0.004
Significant	14	35	49 (0.7)		

Figures

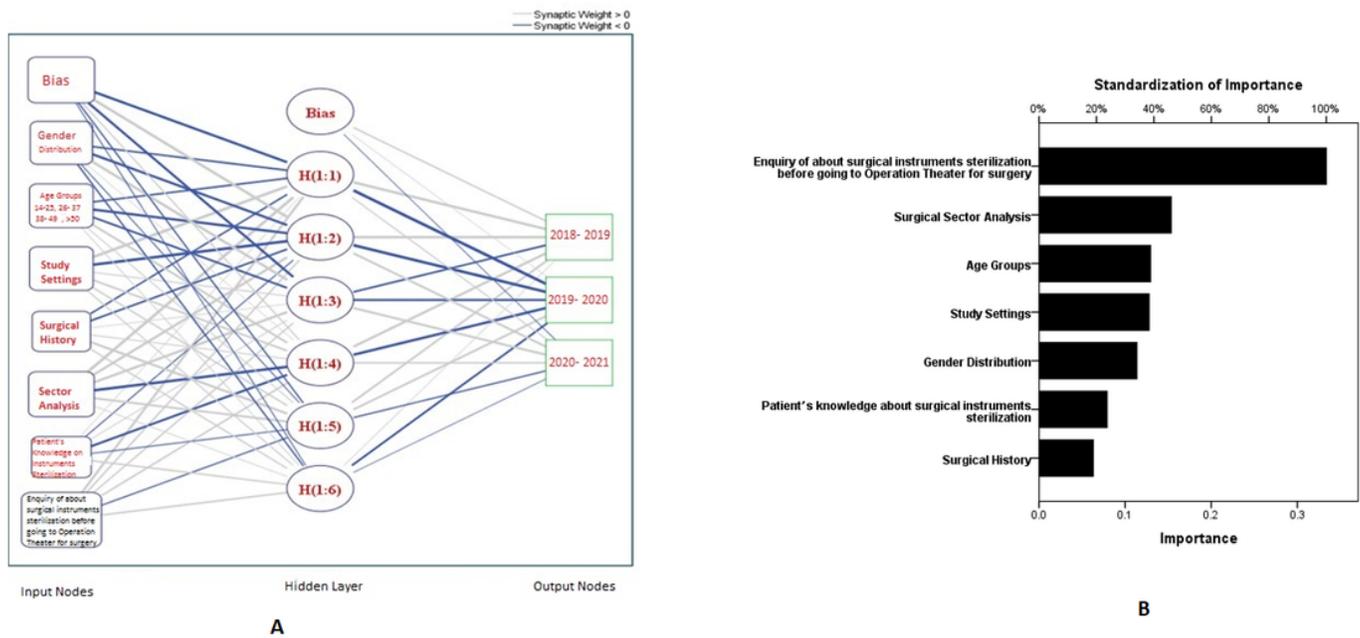
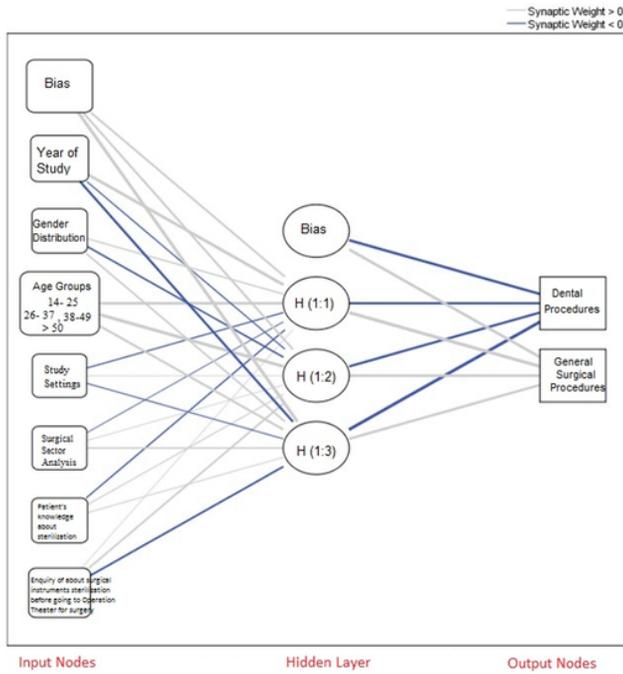


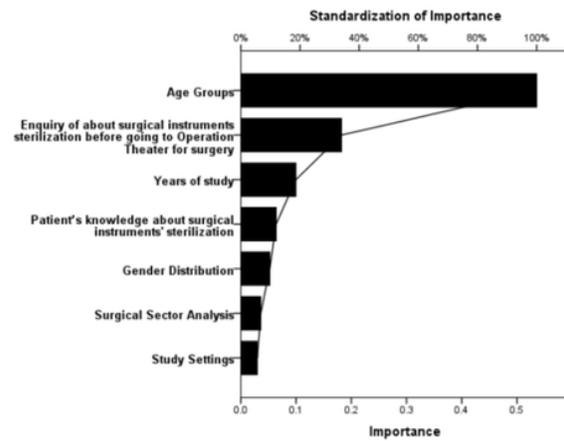
Figure 1

A: Schematic representation of the ANN model developed to find the yearly transmission of hepatitis C viruses. Abbreviation: ANN, artificial neural network.

B: The relative importance of the factors to the ANN model.



A



B

Figure 2

A: Schematic representation of the ANN model developed to find the source of hepatitis C transmission from dental procedures or general surgical procedures. Abbreviation: ANN, artificial neural network.

B: The relative importance of the factors to the ANN model.

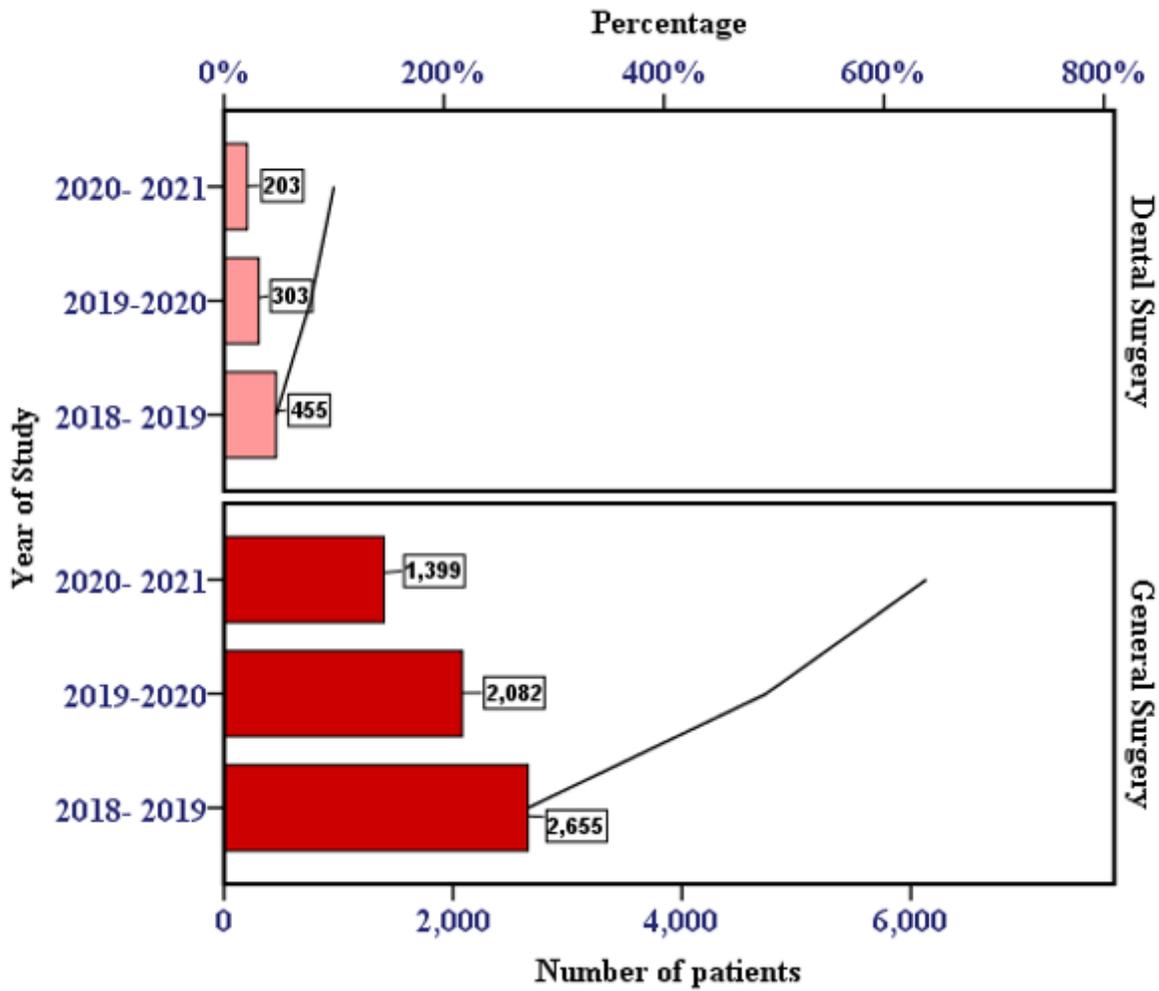


Figure 3

Histogram of a simulated discrete Pareto distribution in Yearly Surgical History of Hepatitis C positive Patients