



## REVIEW ARTICLE

### Hepatitis C in several risk groups: Literature review

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## Abstract

**Aim:** The objective of this study was to assess the distribution of hepatitis C in selected risk groups such as haemodialysis patients, pregnant women, healthcare workers, HIV-HCV co-infected patients, patients with mental health diseases and piercing and tattoo procedures. Furthermore, it aimed at evidencing common transmitting routes and highlighting the importance of preventive measures among these groups.

**Methods:** The literature review was conducted using online databases (Medline) with search query involving the keyword “hepatitis C” in conjunction with keywords describing risk groups such as "dialysis", or "haemodialysis", or "pregnancy", or "pregnant", or "mental health", or "tattoo", or "piercing", or "HIV", or "health professionals”.

**Results:** After assessing all the retrieved publications, 39 of them were considered for inclusion: 17 on haemodialysis patients, 7 on pregnant women, 8 on HIV-HCV co-infection and 7 publications on health professionals, patients of mental health wards and piercing and tattoo procedures. The high rate of hepatitis C is still a high problem and in some cases it is considered as a new issue, as in the case of pregnancy. Some of the transmission routes have been identified earlier, such as the HIV-HCV co-infection but some, such as piercing and tattoo, are becoming new transmission routes. Health professionals are still identified as high risk group while mental health patients are a potentially high risk group.

**Conclusion:** Even though some patients are routinely screened for hepatitis C, there are indications for performing such a routine test in other groups. In almost all of the risk groups, it is advocated to use stricter preventive measures and to disseminate knowledge on risks of hepatitis C.

**Keywords:** haemodialysis, healthcare workers, hepatitis C, human immunodeficiency virus, mental health diseases, piercing and tattoo, pregnancy.

**Conflict of interest:** None declared.

## Introduction

Hepatitis C, as a liver infection, is caused by the Hepatitis C Virus (HCV), blood borne virus. The virus can cause both acute and chronic hepatitis, ranging in severity from a mild illness lasting a few weeks to a serious, lifelong illness. Approximately 60%-80% of infected people may progress to chronic liver disease and 20% of them will develop cirrhosis (1). According to WHO, globally, an estimated 71 million people have chronic hepatitis C infection (2). An estimated 3.5 million people in the United States have chronic hepatitis C (3).

Globally, morbidity and mortality from hepatitis C virus infection (HCV) is increasing. According to estimation from recent studies, more than 185 million people around the world are infected with hepatitis C virus (1). Total global prevalence of HCV is 2.5%, varying from 2.9% in Africa to 1.3% in America, with global viremic rate 67% (118.9 million HCVRNA positive cases), varying from 64.4% in Asia to 74.8% in Australasia (4).

In Europe, the prevalence of hepatitis C (HCV) is estimated to be around 1.7% and includes 13 million cases, the lowest prevalence (0.9%) is reported in Western Europe (except some rural regions in South of Italy and Greece) and the highest prevalence in central Europe (3.1%) specifically in Romania and Russia (5). According to estimation from Global Burden of Disease study, deaths rate from hepatitis C was 333000 in 1990, 499000 in 2010 and 704000 in 2013 (6). These cases of deaths are result of complications from HCV, including liver cirrhosis, hepatocellular carcinoma and liver failure (7).

The following groups are at increased risk for HCV infection:

- Current or former injection drug users;
- Chronic haemodialysis patients;

- People with known exposures to HCV, such as (health care workers after needle sticks involving HCV-positive blood, recipients of blood or organs from a donor who tested HCV-positive);
  - People with HIV infection;
  - Children born to HCV-positive mothers;
  - Patients of mental health wards
- And also were at risk:
- Recipients of clotting factor concentrates made before 1987, when less advanced methods for manufacturing those products were used;
  - Recipients of blood transfusions or solid organ transplants prior 1992, before better testing of blood donors became available (8);

Conversely, the transmission routes and epidemiology include:

- Intravenous drug use;
- Non-intravenous recreational drug exposure;
- Healthcare procedures;
- Accidental exposure;
- Mother to child vertical transmission;
- Sexual exposure etc. (8).

## Methods

### *Search and study identification*

The aim of the study was to identify, through literature review, studies addressing the following:

- cases of Hepatitis C,
- most common transmitting route,
- the importance of preventive measures,

among several risk groups such as: haemodialysis patients, pregnant women, healthcare

workers, HIV-HCV co-infected patients, patients with mental health diseases and practitioners of piercing and tattoo.

Articles published were identified by literature survey in online database Medline through PubMed interface, using keywords:

"hepatitis C"

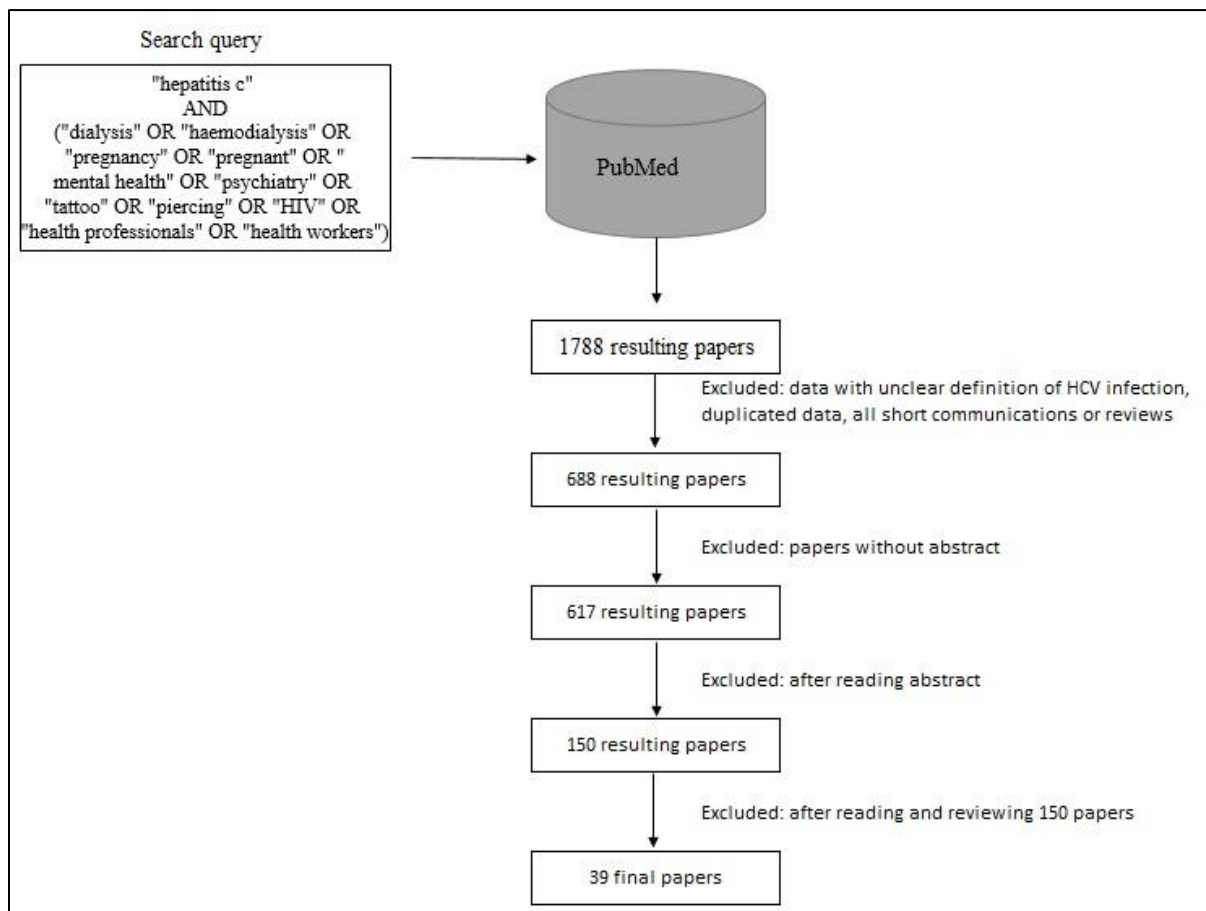
AND

("dialysis" OR "haemodialysis" OR "pregnancy" OR "pregnant" OR "mental health" OR "psychiatry" OR "tattoo" OR "piercing" OR "HIV" OR "health professionals" OR "health workers").

From the search query, 1788 publications were identified and from these only original publications were included. The following

data were excluded from our analysis: data with unclear definition of HCV infection, duplicated data, all short communications or reviews. Next, the remaining 688 publications were selected and after removing publications without abstract, there were left 617 of them. After reading abstracts of 617 publications we selected 150 publications that fulfilled our research interests. All 150 publications were studied and publications that dealt with detailed treatments, or included other groups of interests were excluded. Finally, we selected 39 publications for analysing and presenting their results, as presented in Figure 1.

**Figure 1. Search and study identification**

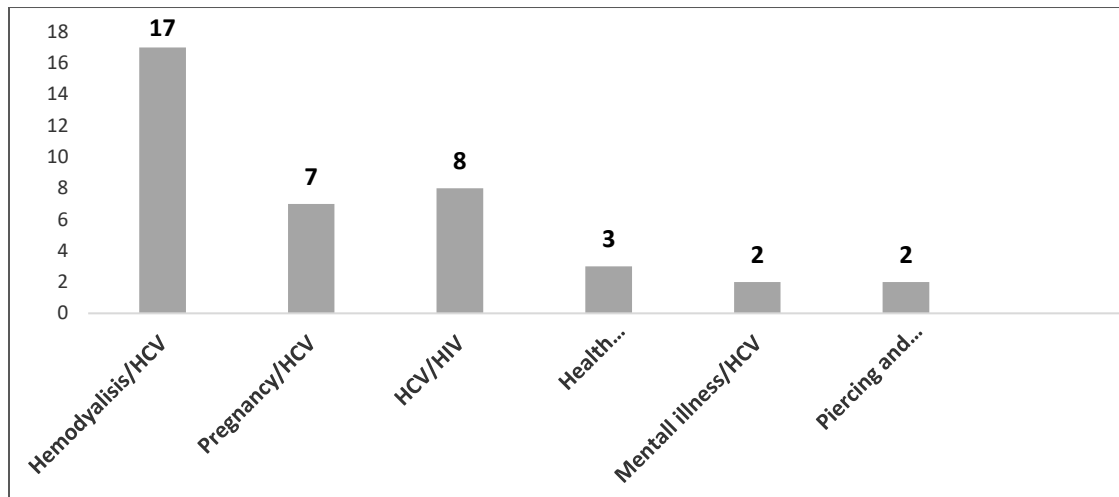


### Overview of the results

After a full text screening, as presented in Figure 2, a total of 39 articles were considered for inclusion: 17 on haemodialysis patients, 7 on pregnant women, 8 on HIV-HCV

coinfection and in total 7 publications on health professionals, patients of mental health wards and piercing and tattoo procedures. In following sections, each group will be discussed and in the end of each section, a short conclusion will be presented.

**Figure 2. Publications with HCV data by risk groups**



### Results on Haemodialysis / HCV

From 17 publications on HCV and haemodialysis, 10 of the publications included on their results prevalence of HCV on Haemodialysis centres, while 7 other publications included on their result other findings or association of HCV with other factors. For HCV, prevalence estimates that were considered representative for haemodialysis centres were available for 10 countries as presented in Table 1. A prospective study conducted in Japan in 2016 (9) included 41 haemodialysis centres, with total of 2986 haemodialysis patients. The aim of the study was to screen for HCV antibody, and HCV RNA, but as well to determine genotype of hepatitis C and the treatment of HCV patients. In its findings, authors have reported that 5.02% of patients were HCV Ab positive and from this number 72.31% were HCV RNA positive. Another

interesting conclusion of the study, was that 62.1% of tested patients were HCV genotype 1 and that the combined therapy of Daclatasvir and Asunaprevir was effective at HCV positive patients in haemodialysis. Another study performed in Japan, but this time a retrospective one (10), included 3064 patients on haemodialysis. The aim of the study was to find the association of hepatitis C virus infection with the prognosis of chronic haemodialysis patients. The results of the study suggested that of those patients, 14.0% were HCV RNA positive, while 2.4% were HBsAg positive and 0.3% were double positive. Also in the study, it was reported that by 2010, 49% of haemodialysis patients were deceased. From that percentage, 60% of them were HCV RNA positive, and 47% HCV RNA negative. A prospective study was con-

ducted in Brazil (11) that included 798 haemodialysis patients, with the aim of determination of prevalence of HCV infection and genotypes in patients undergoing haemodialysis. The study found that performing ELISA test, 8.4% of the patients resulted HCV positive, while 86.1% of them had determined viral genotype 1 and 11.6% determined genotype 2 and 2.3% determined genotype 3. One of the suggestions of the authors was to strengthen the control strategies for hepatitis C in haemodialysis centres. A cross-sectional study conducted in China in 2013 (12), included 2120 patients on haemodialysis and 409 patient partners. This study investigated the prevalence and risk factors of HCV and HBV infection and the distribution of HCV genotypes among haemodialysis patients and their spouses. Authors findings were that 6.1% of the patients were anti-HCV positive, 4.6% of them were HCV RNA and 7.0% of them resulted in HBsAg positive. Regarding the prevalence of their partners, it resulted that 0.5% of them were anti-HCV positive, while 0.2% RNA HCV positive and 4.2% HBsAg positive. Some of the risk factors that authors have mentioned were: the duration of dialysis and blood transfusion. The predominant genotype was 1b with 89% while 2a had 7.7% and genotype 3a, 3b, 6a each by 1.1%. Authors' suggestion, due to the persistence of nosocomial infection, were strict infection control measures to be strengthened with the aim of reducing the transmission of HCV.

Another prospective study, that involved 170 patients on haemodialysis, was performed in US (13), with the aim to overview the incidence and preventive measures for HCV in the haemodialysis centre. The study resulted in finding 5.4% new HCV cases, from which 4 cases were genotype 1a, 2 cases of genotype 1b. The other 37.6% of old cases, 29 cases were genotype 1a, 16 cases were genotype 1b, and 2 cases were genotype 3a.

Cross sectional survey in Sudan included 353 patients of haemodialysis, aiming to determine the seroprevalence and risk factors for hepatitis C and hepatitis B in their dialysis centres (14). Their finding resulted in 16 cases that were HBsAg positive and 30 cases that were anti-HCV positive. The long duration of dialysis and surgical intervention, were most common risk factors, related to infection. In the Middle East, authors (15) conducted a prospective investigation, to find the impact of an identical isolation policy on incidence of nosocomial HCV infection in haemodialysis centre. Study was conducted in two phases, phase one involving 189 patients and phase two involving 198 patients affected of haemodialysis. Their study resulted in finding 83 (43.9%) phase one patients with anti HCV positive, while the remaining 106 (56.1%) patients resulted as anti HCV negative. An interesting fact is the correlation between HCV positivity and the dialytic age (of 83 patients who had positive results for anti-HCV antibodies had a mean dialytic age of  $48.5 \pm 14.2$  months, compared with  $25.0 \pm 8.6$  months among the 106 anti-HCV-negative patients). In phase II, they had similar results, 85 (42.9%) of 198 patients had anti-HCV positive results, and 113 (57.1%) continued to have a negative status for anti-HCV antibodies. Interesting relation between phase one and two is the addition of two new anti-HCV positive cases (none of them belonging to the added 9 after phase one), that occurred over 12 months of study period, leading to an HCV seroconversion rate of 1.01% per year (15). Netherlands conducted a nationwide prospective study on the prevalence and incidence of Hepatitis C virus infections among dialysis patients in 1996 (16). In 34 haemodialysis centres, a total of 2281 patients were included, dividing the research into two phases: the first phase with 2281 patients – where the HCV RNA positive rate was 2.9%, and the second phase after one

year with the sample of 2286 patients, where 3.4% of the cases were HCV RNA positive. Main risk factors were also identified by the study, and those being: haemodialysis before 1992, kidney transplantation before 1994, birth in other countries, and receiving dialysis abroad during vacations. Another cross sectional study was conducted in Canada, aiming to study Hepatitis C prevalence and risk factors in dialysis population, with 336 patients included in the study (17). The study resulted in finding that prevalence of anti-

HCV antibody was 6.5% (22/336), 77.2% (17/22) of cases that were anti-HCV positive resulted HCV RNA positive. Another prospective study was conducted with 128 patients in USA, with findings of 25% of them positive HCV EIA (18), but tests were not specific because in 6 cases it was detected and resulted negative, which speaks about past infection. It is known that PCR remains the only reliable test to determine the presence of the virus.

**Table 1. Hepatitis C in haemodialysis centres**

Paper	Year	Country	Study design	Study sample	Laboratory tests	HCV Ab Positive	HCV RNA positive
(9)	2016	Japan	Prospective	2986	HCV anti-body, HCV RNA	5.02%	From total of HCV Ab positive cases, 72.31% were HCV RNA positive
(10)	2010	Japan	Retrospective	3064	HCV RNA	/	14.00%
(11)	2013	Brazil	Prospective	798	HCV anti-body	8.40%	/
(12)	2013	China	Cross-sectional	2120	HCV anti-body, HCV RNA	6.10%	From total of HCV Ab positive cases 4.6% were HCV RNA positive;
(13)	2009	USA	Prospective	170	HCV RNA	/	5.4% new HCV cases and 37.6% older HCV cases
(14)	2010	Sudan	Cross-sectional	353	HCV anti-body	8.50%	/
(15)	2003	Arabia	Retrospective and prospective	189	HCV anti-body	Phase I, 43.9% Phase II, 42.9%	/
(16)	1996	Netherlands	Prospective	2281 (phase I) 2286 (phase II)	HCV RNA	/	First phase 2.9%; Second phase 3.4%
(17)	1997	Canada	Cross-sectional	336	HCV anti-body, HCV RNA	6.5% HCV	From total of HCV Ab positive cases 77.2% were

							HCV RNA positive
(18)	1998	USA	Prospective	128	HCV anti-body	25%	/

In relation to haemodialysis patients, some other studies were conducted to find the connection between haemodialysis patients and HCV and other risk factors. Since that connection is believed to be of importance, findings of those studies are briefly presented in the following paragraphs. One of the studies investigated bleeding epidemic that has erupted on September-October 2013, in haemodialysis unit in Vietnam, involving 119 patients with 9 positive HCV cases and 9 positive HBV cases. Authors found that HCV prevalence in the epidemic was 6%, which is 7.5 times higher than in the vast population of Vietnam (19). Another retrospective study conducted in USA found correlation between HCV and hepatocellular carcinoma (HCC), when checking 32860 HCV cases, that resulted in 262 cases with HCC (20). HCC was 12 times more common in cases of cirrhosis, 3 times more frequent in cases of alcohol consumption and 1.3 times higher in cases of diabetes, with the likelihood of HCC increasing with age. Another correlation, this time linear, between incidence and prevalence, was found in a study in France, concluding that doubling the value of P(C) doubles the incidence of cases with hepatitis C (21). A prospective study conducted in Spain, found initial prevalence ( $p < 0.0001$ ) and time ( $p < 0.0001$ ) emerging as independent variables associated with the decrease of HCV prevalence (22). Authors of another study, conducted in France, found that HCV seroconversion was associated with the number of hemodialysis sessions undergone on a machine shared with or in the same room as a patient who was anti-HCV (genotype 2a/2c) positive (23). A cross sectional study in USA

found by using multivariate logistic regression analysis, that the longer duration of receiving dialysis associated with a history of intravenous drug use, were the only risk factors that remained independently associated with HCV seropositivity (24). Authors of a study in France found that overall, HCV RNA became undetectable in 16 patients (69.6%) 1 month after starting IFN- $\alpha$  therapy and in 21 patients (91.3%) at the end of treatment (25).

#### **Results on Pregnancy /HCV**

Conducting the literature review, 7 studies that presented a relation between HCV infection and pregnancy were included, as shown in Table 2. A research conducted in Pakistan (26), enrolled 119 cases of pregnant women with HCV positive, and 238 control cases, from the total of 5621 pregnant women, of whom 5339 were screened. Their result showed that iatrogenic exposure (health care injections, hospitalizations and pregnancies) are the major risk factors for transmission of HCV among pregnant women. Therefore, the authors call for strengthening the prevention aspect of the hepatitis control program to focus on behaviour change for reducing injection reuse and overuse. A study in the USA, which included 1013 obstetric patients identified that use of intravenous drugs resulted as the fastest risk factor (27) in HCV. Authors emphasize that the epidemiologic data are consistent with sexual and parenteral modes of transmission, however, according to them routine screening for hepatitis C is not advocated. Another study in the USA, with 599 pregnant hospitalised women, identified



4.3% were HCV positive, from which 3 positive HIV cases, and 2 of them had coinfection with hepatitis C. Another correlation between hepatitis B and hepatitis C, resulted in 1 coinfection from 5 cases with hepatitis B (28). Another study in Italy, reported that HCV transmission was higher in mothers with fluctuating ALT levels (31/154; 20.1%) when compared with mothers with normal ALT levels (35/292; 12%). The HCV transmission was the highest in the group of mothers with constantly raised ALT levels (8/31; 25.8%) (29). Vertical transmission of HCV was investigated in three studies. The first study (30), had as a subject 2447 HCV pregnant women, from whom 78 women (3.2%) were anti-HCV positive, 60 women (2.5% or 77% of all cases of positive anti-HCV) were positive HCV-RNAs. Regarding the newborns, 60 of them (50%) remained HCV-RNA negative, throughout 22 of them (36.7%) were RNA-HCV positive in one case

and 8 of them (13.3%) were RNA-HCV positive at least in the two following tests and only 2 children (3.3%) remained positive RNA-HCV, testing after 8 to 24 months (30). The second vertical transmission study was conducted in Ireland with 36 HCV pregnant women (31). From the study resulted that all 36 cases were positive when tested with Elisa and 26 women (76%) were PCR positive for HCV genotype 1. In terms of vertical transmission only one child resulted positive when tested with PCR HCV (31). The third study conducted with 3712 pregnant women, resulted in 35 (0.94%) women that were anti-HCV positive and out of this number 20 women (57%) were HCV RNA positive (32). The vertical transmission rate was 5%, where only one new-born of 29 of maternal RNA HCVs positive resulted HCV RNA even after 12 months of birth that speaks for HCV persistent infection (32).

**Table 2. Hepatitis C related to pregnancy**

Paper	Year	Country	Study design	Study sample	Laboratory tests	Results
(26)	2006	Pakistan	Case control	5339	Elisa HCV	119 (2%) were HCV positive
(27)	1992	USA	Prospective	1005	HCV antibody	2.28% (N = 23) were HCV positive
(28)	1994	USA	Prospective	599	Elisa HCV	4.3% were HCV positive
(29)	2006	Italy	Case control	74 HCV RNA transmitting mothers and 403 HCVRNA not transmitting	HCV RNA, ALT	HCV transmission was higher in mothers with fluctuating ALT levels (31/154; 20.1%) when compared with mothers with normal ALT levels (35/292; 12%)
(30)	1997	Italy	Prospective	78 HCV positive	Anti-HCV, HCV RNA	8 of 60 (13.3%) infants born to HCV-RNA positive mothers acquired HCV infection, but only 2 (3.3%) were still infected by the end of follow-up.
(31)	2001	Ireland	Retrospective	36 women with HCV	Elisa HCV. HCV RNA	The 36 cases were positive Elisa and 26 (76%) were PCR positive for HCV genotype 1b. In terms of

						vertical transmission only one child resulted positive PCR HCV.
(32)	1996	Germany	Prospective	3712 pregnant women	Anti-HCV, HCV RNA	Out of 3712 women, 35 (0.94%) were anti-HCV positive and out of this number 20 (57%) were HCV RNA positive. The vertical transmission rate was 5%.

### Results on HIV / HCV coinfection

Regarding the relation between the HCV and HIV, a number of research papers, presented in Table 3, discussed the coinfection, while proving unfortunately that the problem is on the rise. The first study reviewed, was a prospective study performed in Ghana, where from 1520 HIV infected cases, HCV RNA test was performed in all HBsAG positive subjects (n=236) and a random subset of HBsAg negative subjects (n=172), which resulted in 4 positive cases (3 cases of genotype 2 and 1 case of genotype 1). From these four infected cases surgical procedures and blood transfusion procedure was reported as an important risk factor for HCV infection (33).

In 2018, a study in Spain was performed including 322 patients with Hepatocellular carcinoma in patients with HIV/HCV coinfection (34). The study aimed finding the relationship between the use of antiviral agents and the risk of HCC in HIV/Hepatitis C co-infected patients. As a result, 42 (13%) of patients occurred after sustained virological response. It is interesting to mention that after using direct antiviral agents in HIV/HCV co-infected patients, the frequency of hepatocellular carcinoma was not increased. A study conducted in Canada between 2005 and 2015, examined the relationship between HIV-seropositivity and having access to a physician for regular HCV care (35). In total, 1627 HCV-positive cases were eligible for analysis; from whom 582 (35.8%) were HIV-positive at baseline and 31 (1.9%) became HIV-positive during follow-up. Their results demonstrated a positive relationship between HIV-seropositivity and having access to a

physician for regular HCV care, which is partially explained through increased frequency of engagement in health care (35). In 11 European countries, data were used for performing retrospective and cross sectional study with 229 HCV / HIV cases of children and young adults (36). That resulted in 63% of cases that were infected with hepatitis C vertically, 7% of them were infected with hepatitis C as nosocomial infection, 17% with drug use and 13% of them has no data about the way of infection. Study also reveals that among infected patients with hepatitis C, a high number of patients with progressive liver disease was present, so it suggests the importance of improving monitoring procedures and offering earlier HCV proper treatment (36). A study in 9 emergency units in England, in 2014, during “Going Viral” campaign, 7807 patients were tested (37). That resulted in 39 HCV infected persons (15 newly diagnosed), 17 HIV infected persons (six newly diagnosed), and 15 HBV infected persons (11 newly diagnosed). It also revealed that those aged 25–54 years had the highest prevalence: 2.46% for HCV, 1.36% for HIV and 1.09% for HBV. Another study performed with 4950 participants in some regions in China resulted with HIV and HCV prevalence of Yanyuan county were 0.06% and 0.15%, respectively. HCV prevalence of Muli county was 0.06% HCV and none was found to be HIV positive (38). Another important finding from this survey was that HIV epidemics has not spread from high risk groups to the general population.

A systematic review and meta-analyses of 10 studies (39), 2382 infants, were included in



an analysis of HCV-infected mothers (defined by anti-HCV and antibody assays) with and without concomitant HIV infection. The risk estimate of HCV vertical transmission was 2.82 from anti-HCV positive/HIV positive co-infected mothers compared with anti-

HCV positive/ HIV negative mothers. This finding revealed that the risk of HCV vertical transmission is higher in infants born to HIV co-infected mothers.

**Table 3. HIV – HCV coinfection**

Paper	Year	Country	Study design	Study sample	Laboratory tests	Results
(33)	2014	Ghana	Prospective study	From 1520 infected HIV, all HBsAg-positive subjects (n = 236) and a random subset of HBsAg-negative subject (n = 172) were screened for HCV RNA	HCV RNA	4 positive cases
(34)	2018	Spain	Prospective study	322 HCC cases in HIV/HCV co-infected patients	n/a	After SVR 42 cases (13%)
(35)	2005-2015	Canada	Prospective cohort	1627 HCV positive cases	HCV RNA, HIV test	582 (35.8%) were HIV-positive at baseline; and 31 (1.9%) became HIV-positive during follow-up
(36)	2016	11 European countries	Retrospective cross sectional	229 children and young adults with HIV/HCV	HCV RNA, HIV RNA	63% of cases infected with hepatitis C vertically, 7% infected with hepatitis C as nosocomial infection, 17% drug use and 13% no data
(37)	2014	England	Prospective	9 units of emergency departments (7807 patients)	HIVAg/Ab, HBsAg, HCV Ab	39 HCV infections (15 newly diagnosed), 17 HIV infections (six newly diagnosed), and 15 HBV infections (11 newly diagnosed).
(38)	2011	China	Randomised prospective	4950 participant	Elisa HIV, Elisa HCV	HIV and HCV prevalence of Yanyuan county were 0.06% and 0.15%, respectively. HCV prevalence of Muli county was 0.06% HCV and none was found to be HIV positive
(39)	2003	USA	A systematic review	2382 infants from HCV infected mothers	HIV RNA, HCV RNA	Risk estimate of HCV vertical transmission was 2.82 from anti-HCV+/HIV+ co-infected mothers compared with anti-HCV+/HIV-mothers
(40)	2014	USA	Review of recommendations	/	/	/

### ***Results on health workers, tattoo and piercing procedures, patients of mental units / HCV***

Three of seven studies involved in the survey and presented in Table 4, revealed that health practitioners are the major risk group of getting HCV while giving care to their positive HCV patients. Study on health care professionals approach to patients with hepatitis C revealed that during treatment they use stricter measures to protect themselves from infection (40). In the study, a questionnaire was sent to 3675 health professionals and in the end 1347 completed questionnaires were taken for analysis. As a final result, the study suggests that focusing education strategies on changing health practitioners' attitudes toward people with hepatitis C, injecting drug users, and infection control guidelines rather than concentrating solely on medical information might ultimately improve patient care. Another study conducted in USA, revealed that HIV and HCV infection was transmitted to health care workers from nursing home patients, when they dealt with these infections through non-intact skin exposure. In these cases, the infection may have been prevented by consistent, unflinching use of barrier preventive measures (41). In Italy the research that was performed in 9 haemodialysis centres with 1002 patients for detecting infection with hepatitis B, Hepatitis C and HIV, resulted with prevalence of HBsAg in patients of 5.1%; HCV antibody 39.4%; antibodies to HIV 0.1%. Another important result in this study emphasized that health professionals in haemodialytic centres has 4000 and 8000 times lower for HIV than for hepatitis B and hepatitis C, respectively (42). Regarding the relation of HCV with mental illness, in the review are included two studies. The first study, with 293 veterans with HCV positive, resulted with 93% of the participants had at least one psychiatric problem and 73% had more than 2 mental disorders

(43). The authors concluded that the routine screening for underlying psychiatric and substance use disorders and early treatment intervention before initiating antiviral therapy is essential. Another study with 931 patients with mental illness, revealed that among this group there is a high number of infected persons with HIV, hepatitis B and hepatitis C - 3.1% with HIV, 23.4% cases with hepatitis B and 19.6% cases with HCV (44). A big problem, authors found, is the large number of undetected cases with hepatitis C, and delay in detection is related to treatment delay and also might be a source of infection to others. Regarding the relation of HCV and tattooing or piercing procedures, two studies are included. The first study, of 10 case-control studies, 6 reported no increased risk of HCV infection from tattooing when they controlled for injected drug use and other risk behaviours, and 2 studies reported a 2–3 times higher risk for HCV infection when the tattoo was received in nonprofessional settings (45). Another study about knowledge of tattoo practitioners about HCV and transmission revealed that from 35 employees, 34 were aware of guidelines and body piercing (46). The average number of piercing procedures during the week was 5.5. Study showed that body-piercing practitioners had inadequate training, and lacked knowledge and understanding of HCV transmission, infection control, and universal precautions. As a conclusion health care practitioners are in high risk for getting HCV infection from infected patients, so they should stricter measures. Also it was identified high rate of HCV infection among patient with mental health diseases, and large number of undetected cases, that is a sign for occurring epidemics inside mental health wards. Another conclusion related to piercing and tattoo procedures revealed that risk of HCV infection is significant among risk groups. Also lack of knowledge about HCV transmission among

body piercing and tattoo practitioners could be a risk factor on rise.

**Table 4. Hepatitis C related to health care practitioners, mental disease patients, tattoo and piercing procedures**

Paper	Study group	Year	Country	Study design	Results
(41)	Health professionals	2006	Australia	Analytic cross sectional study	Focusing education strategies on changing health practitioners' attitudes toward people with hepatitis C, injecting drug users, and infection control guidelines
(42)	Health professionals	2003	USA	Case report	HIV and HCV transmission from the patient to the HCW appears to have occurred through non-intact skin exposure
(43)	Health professionals	1993	Italy	Prospective	The risk of acquiring infection was calculated to be 8000 times lower for HIV than for hepatitis C.
(44)	Mental health patients	2005	USA	Prospective	93% of the patients had a current or past history of at least 1 psychiatric disorder, and 73% had $\geq 2$ disorders
(45)	Mental health patients	2001	USA	Prospective	Prevalence rates of HBV (23.4%) and HCV (19.6%) were approximately 5 and 11 times the overall estimated population rates for these infections, respectively
(46)	Tattoo and piercing procedures	2015	USA	Meta –analyse	Risk of HCV infection is significant, especially among high-risk groups (adjusted odds ratio, 2.0–3.6), when tattoos are applied in prison settings or by friends
(47)	Tattoo and piercing procedures	2003	Australia	Cross - sectional survey	Body piercing practitioners had inadequate training, and lacked knowledge and understanding of HCV transmission, infection control, and universal precautions

### Discussion

As for the first part of the research on haemodialysis, presented in Table 1, most of the studies were of prospective nature, indicating the importance of following up the relations between the haemodialysis and HCV. Less than half of the studies had a bigger sample than 1000 patients. The timing of haemodialysis and the risk of infection with hepatitis C

virus appear to be in the right proportion, as the years of haemodialysis increase and the risk of acquiring hepatitis C infection increases. The laboratory tests in almost all of the studies, included HCV antibody and/or HCV RNA but considering that HCV RNA test is more expensive, in developing countries like Sudan, only the HCV antibody test

was conducted, which can't differentiate between an active infection versus a chronic or previously acquired infection. But, still the HCV antibody test, can provide an overview of the infected population with hepatitis C.

This is also confirmed by the results of three studies (9,12,17) where over 70% of HCV Ab positive cases were found to be HCV RNA positive. Generally, most of the studies suggest stronger preventive measures and stronger infection control strategies on haemodialysis centres.

The second part of the research, dealing with relation between hepatitis C and pregnancy, presented in Table 2, most of the studies were of prospective nature. Injections (intravenous drugs) and hospitalization were identified as most common pathways of infection of pregnant women with HCV. Other studies focused on vertical transmission, identified that new-borns were infected with HCV. These results emphasise the importance of routine screening for HCV during pregnancy.

The part of the research dealing with hepatitis C and HIV co-infection, identified several publications, where most of them conducted prospective studies. The laboratory tests included HCV RNA and HIV test. Several studies call for routine screening in order to find out if they are infected but as well to offer earlier and proper treatment.

The last part of the research included health care practitioners, mental health patients and tattoo and piercing procedures. According to the publications, health care practitioners are in high risk for getting HCV infection, from infected patients, so they should use stricter measures. Also, a high rate of HCV infection

among patient with mental health diseases was observed, and large number of undetected cases, that is a sign for occurring epidemics inside mental health wards. Meanwhile, related to piercing and tattoo procedures, research revealed that risk of HCV infection is significant among risk groups. Also lack of knowledge about HCV transmission among body piercing and tattoo practitioners could be a risk factor on the rise.

### **Conclusion**

After discussing the most important aspects presented in all 39 papers, the authors' viewpoints are as follows:

- The most common test used to identify hepatitis C is HCV RNA, even though as an expensive test, sometimes Elisa / HCV antibody test can provide a valuable overview on infection.
- Most of the studies were of prospective nature, indicating the importance of following up the disease.
- Almost every study suggests stronger preventive measures and stronger control on haemodialysis centres.
- Unfortunately, the hepatitis C incidence is on the rise.

In line with these viewpoints, it is of paramount importance to emphasize that the routine screening can be life changing in finding out new cases and educating the population about the importance of preventive measures, as well as the early treatment.

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