A Case Control Investigation of Hepatitis C Risk Factors In Hawaii

Lara E. Lasher MPH, Joe L. Elm MS, Quynh Hoang, Trudi S. Nekomoto MS, Thomas M. Cashman MD, MSPH, F. DeWolfe Miller MPH, PhD, and Paul V. Effler MD, MPH


Lara E. Lasher MPH


Joe L. Elm MS


Quynh Hoang


Trudi S. Nekomoto MS


Thomas M. Cashman MD, MSPH

Abstract

This case control investigation of hepatitis C risk factors in Hawaii showed that IV drug use, blood transfusion, tattoos, incarceration, acupuncture, prior dental or oral surgery, and HIV infection were associated with HCV. Future public health efforts in Hawaii should focus on developing effective and appropriate community interventions targeting those with well-established risk factors for HCV.

Introduction

Hepatitis C is the most common chronic blood-borne infection in the United States (U.S.).[1] Approximately four million (1.8%) Americans are currently infected with hepatitis C virus (HCV) and an estimated 35,000 new infections occur each year.[2] More than half of HCV infections progress to chronic hepatitis; chronic hepatitis is the tenth leading cause of death for adults in the U.S.[3,4] Between 10,000 and 12,000 people in the U.S. die each year from HCV related chronic liver disease.[2] Reported rates of infection in other parts of the world vary from 0.3% to 14.5%.[3]

Direct exposure to blood is the most efficient method of transmitting HCV. Prior to July 1992, when widespread HCV blood screening was introduced, transfusion of blood and blood products was a major route of exposure for HCV infection in the United States.[5] Since 1992, injection drug-use is believed to account for most new HCV infections. There is currently no recognized source of infection for about 10% of reported HCV cases.

Mandatory reporting of acute and chronic hepatitis C infections was initiated in Hawaii in October 1997. HCV infections are reported to the Hawaii Department of Health (HDOH) from clinical laboratories and health care providers.

The composition of Hawaii's population of 1.2 million differs from that of the U.S. mainland in that there is no ethnic or racial majority. Approximately one quarter of Hawaii's residents describe themselves as white (24%) or black (2%) The remainder self-identify as Asian, Pacific Islander, or mixed race.[6] In addition, the 2000 Census indicates that Hawaii holds the fourth highest proportion of foreign-born residents (18%) in the country.[7] Because of these population characteristics, the State of Hawaii Department of Health (HDOH) conducted an investigation to assess whether locally distinctive factors, such as the high prevalence of traditional tattooing or immigration from areas with elevated rates of HCV, might be important in understanding risk factors for HCV infection in Hawaii. Here we present our findings comparing HCV cases to controls, in terms of demographic characteristics, exposures and behaviors.

Methods

Case Definition

Eligible cases were residents of Hawaii, 18 years of age or older, with a working telephone number recorded on a laboratory report or clinical record who had either: 1) two or more positive enyzme linked immuno-absorbent assays (ELISA) and a confirmatory recombinant immunoblot assay (RIBA) **or** 2) >500 HCV genome pairs/ml in the polymerase chain reaction (PCR) assay reported to HDOH between January 1, 1998 and November 5, 1999.

Patients reported to HDOH who met these criteria were telephoned and briefly interviewed to confirm their age, address, and knowledge of their HCV status. Prospective participants were informed about the study and asked for their consent to receive the study questionnaire by mail; 529 sequential telephone contacts were made to enroll the target number of 500 HCV cases.

Control Selection

Controls were selected from telephone numbers obtained with the InfoTYME CD telephone directory produced by Polk Directories, Livonia, MI. The first five numbers of a telephone number in Hawaii define a geographic "trunk". Using the trunk derived from the telephone number of each HCV case, a list of 50 telephone numbers and their accompanying addresses was generated with Epi Info v. 6.04c, then five telephone numbers were randomly selected from the list. Because some numbers on these lists were vacant or belonged to businesses, typically three to four residential controls were obtained in this fashion

for each case. In total, questionnaires were mailed to the residences of 1749 potential controls. Because telephone numbers with the same trunk are geographically proximal, this methodology served to match cases and controls in terms of residential location, and indirectly, socio-economic status.

Self-Administered Questionnaire/Confidentiality/ Response Rate

All prospective study participants were sent a letter explaining the study and participant rights, a mail-in questionnaire, and a self-addressed stamped envelope. The study packet for controls also included an incentive coupon redeemable for $10 of skin-care products. Voluntary completion and return of the questionnaire was interpreted as participation with informed consent. Questionnaires were returned by 222 (44%) of the 500 cases and 712 (41%) of the 1749 potential study controls selected for the study. Thirteen (1.8%) of the potential controls that reported a history of a positive HCV test were excluded from the study, leaving 699 controls. In order to blind investigators to the geographic origin of the anonymous questionnairres, mailing envelopes were immediately destroyed upon receipt at HDOH.

Statistical Analyses

Epi Info 6.04c and SPSS were used for descriptive statistics and multivariate analyses, respectively. All variables were dichotomized, except for age, race, education, place of birth, county of residence, and number of lifetime sexual partners, which were categorized based upon data distribution. Univariate analyses were used to compare HCV cases and controls for demographic, behavioral and occupational, drug use, and sexual behavior variables. Odds ratios (OR), 95% confidence intervals (95% CI), and p-values (p) were calculated to measure the strength of association between cases and controls in terms of each risk factor.

In order to control for confounding and to determine which exposures were important in predicting HCV infection, multivariate models were created containing exposures shown to have a statistically significant association ($p < 0.05$) in the univariate analyses. The "inclusive" iteration of the model included all factors significantly associated with HCV infection in the univariate analyses with four exceptions: sex with an IV drug user, sex with a HCV-infected partner, the number of lifetime sexual partners, and having had surgery before 1992, each of which had missing values for 30% (276) or more of the respondents. In aggregate, the "inclusive" multivariate model simultaneously examined 23 variables using 721 (78%) of the 921 records in the analysis.

A "restricted" multivariate model was created to examine whether there were additional behavioral risk factors associated with HCV infection that were being eliminated due to the exclusion of 200 records with missing values from the "inclusive" analysis. In the "restricted" multivariate model, all drug use behaviors were represented in the model by IV drug use. Furthermore, birthplace, age, race, and education were excluded because these are non-modifiable socio-demographic characteristics. Ultimately, the final "restricted" model simultaneously examined 12 variables using 781 (85%) of the 921 records in the analysis.

In both the "inclusive" and "restricted" models, variables with p-values < 0.05 were considered to be significantly associated with HCV infection.

Results

Demographics (Table 1)

A higher proportion of persons with HCV infection reported being male (58.3%) than female, but gender was not significantly associated with HCV (OR=1.1, 95% CI=0.8-1.5).

Race was significantly associated with hepatitis C infection. Cases were more likely than controls to be white (OR=7.3, 95% CI=4.2-12.5) or African American / Hispanic (OR=13.4, 95% CI = 6.1-29.6) than Japanese or another Asian race.

Age was also significantly associated with HCV infection. Cases were more likely than controls to be between 41 and 50 years of age (OR=2.2, 95%CI = 1.4-3.5) and less likely to be over 60 years of age (OR=0.2, 95% CI = 0.1-0.4).

Place of birth was significantly associated with HCV infection. Cases were less likely than controls to be born in Hawaii or Asia than on the US mainland (OR=2.6, 95% CI = 1.4-4.7) or somewhere besides the US or Asia (OR=2.6, 95% CI = 1.1-5.9).

Finally, educational level was found to be significantly associated with HCV infection. Persons who had some college education, but who had not graduated, and those with a high school education or less were over-represented among HCV cases (OR=2.7, 95% CI=1.7-4.3 and OR=1.9, 95% CI=1.2-2.9, respectively).

Medical, Occupational and Other Percutaneous Exposures (Table 2)

Univariate analyses revealed significant associations between HCV and risk factors involving exposure to blood. Cases were more likely than controls to report having had a blood transfusion (OR=3.4, 95% CI = 2.3-5.0), hemophilia or a blood disorder (OR=5.0, 95% CI = 2.4-10.3), dental or oral surgery (OR=2.0, 95% CI = 1.2-3.4), or a major surgery before 1992 (OR=2.4, 95% CI = 1.3-4.5). Hepatitis C was also significantly associated with a history of working in a healthcare setting (OR=1.8, 95% CI = 1.2-2.6) and having had acupuncture (OR=2.9, 95% CI = 2.0-4.1).

DeWolfe Miller MPH, PhD

Paul V. Effler MD, MPH

Financial support for this project was provided by the ELC Cooperative Agreement Grant No. U50/CCU012395; Schering-Plough provided coupons for skin care products that were used as incentives for responding to the study questionnaire.

Authors' Affiliations
- Disease Investigation Branch, Hawaii State Department of Health, Honolulu, HI 96813 (L.E.L., J.L.E., T.S.N., T.M.C.)
- Public Health Sciences Program, University of Hawaii, Honolulu, HI, 96822 (Q.H.)
- John A. Burns School of Medicine, University of Hawaii, Honolulu, HI 96813 (D.M.)
- Disease Outbreak Control Division, Hawaii State Department of Health, Honolulu, HI 96813 (P.V.E.)

Lara E Lasher MPH
Epidemiology Specialist
Hawaii State Department of Health
1132 Bishop Street, Suite 1900
Honolulu, HI 96813
Ph: (808) 586-4586
Fax: (808) 586-4595
E-mail: lara.lasher@doh.hawaii.gov

Table 1.— Demographic risk factors. Univariate analysis. Yates corrected chi-square, Odds Ratios, 95% CI and P-values				
Variables	Cases (n=222) Number (%)	Controls (n=699) Number (%)	Chi-square OR (95% CI)	P-value
Gender			=0.5	0.473
Female	90 (41.7)	311 (44.7)	reference	
Male	126 (58.3)	384 (55.3)	1.1 (0.8-1.5)	0.426
Race			$\chi^2 = 80.6$	0.000
White	113 (60.1)	230 (33.8)	7.3 (4.2-12.5)	0.000
Japanese	17 (9.0)	252 (37.0)	reference	
Other Asian	39 (20.7)	178 (26.1)	3.2 (1.8-5.9)	0.000
African American/Hispanic	19 (10.1)	21 (3.1)	13.4 (6.1-29.6)	0.000
Age (years)			$\chi^2 = 93.6$	0.000
≤40	32 (14.8)	100 (14.7)	reference	
41-50	107 (49.5)	153 (22.4)	2.2 (1.4-3.5)	0.001
51-60	56 (25.9)	142 (20.8)	1.2 (0.7-2.0)	0.417
>60	21 (9.7)	287 (42.1)	0.2 (0.1-0.4)	0.000
Place of Birth			$\chi^2 = 54.8$	0.000
Hawaii	74 (33.8)	411 (59.1)	0.8 (0.4-1.4)	0.428
Mainland	114 (52.1)	193 (27.7)	2.6 (1.4-4.7)	0.002
Asia	15 (6.8)	65 (9.3)	reference	
Other	16 (7.3)	27 (3.9)	2.6 (1.1-5.9)	0.027
Education			$\chi^2 = 29.6$	0.000
High school or less	72 (37.5)	218 (32.1)	1.9 (1.2-2.9)	0.006
Some College	70 (36.5)	147 (21.6)	2.7 (1.7-4.3)	0.000
College Graduate	34 (17.7)	193 (28.4)	reference	
Graduate Degree	16 (8.3)	121 (17.8)	0.8 (0.4-1.4)	0.377

Drug Use Risk Factors (Table 3)

Univariate analyses showed that drug use was a significant risk factor for HCV infection. Using IV drugs, heroin, cocaine, crack cocaine, methamphetamines, amphetamines and simultaneous use of cocaine and heroin (speedball), were reported more frequently among persons with HCV infection than among controls (ORs >>1, p=0.000). Use of steroids was not significantly associated with HCV infection (OR=2.1, 95% CI = 0.8-5.8). Never having used any of the drugs queried was found to be a protective factor (OR=0.1, 95% CI = 0.06-0.14).

Sexual Behavior Risk Factors (Table 4)

Univariate analyses of sexual practices and sexually transmitted infections are shown in table 4. Having had sex with someone known to have HCV infection and having had sex with an IV drug user were reported more frequently by cases (OR=25.0, 95% CI = 11.5-54.9 and OR=52.9, 95% CI = 28.0-101.2, respectively). A history of gonorrhea, HIV, or syphilis was significantly associated with HCV (OR=4.6, 95% CI = 2.8-7.6; OR=9.7, 95% CI = 1.7-70.8; and OR=19.4, 95% CI =2.3-437.0, respectively), but a history of chlamydia, genital herpes, and genital warts was not. The reported number of lifetime sexual partners was significantly associated with HCV infection. Cases were more likely than controls to report having 6 or more lifetime partners (6-15 partners: OR =6.4, 95% CI=2.8-14.5 and >15 partners: OR =20.9, 95% CI=9.0-48.4).

Other Exposures (Table 2)

Having received a tattoo by a professional, a tattoo done at home by a friend, and body piercing were each significantly associated with HCV infection (OR= 4.4, 8.9, and 3.0, respectively, 95% CI = 3.0-6.7, 4.4-18.4, 1.3-6.9, respectively). Having been in prison was also more frequently reported for cases than controls (incarceration for less than 6 months: OR=10.6, 95% CI = 5.5-20.7; for 6 months or longer: OR=37.7, 95% CI = 10.8-157.9).

Multivariate Analysis (Table 5)

Among the 23 variables examined simultaneously in the "inclusive" multivariate model, only a history of using intravenous drugs (OR=5.3, 95% CI = 1.4-19.3) and having had a blood transfusion in the past (OR=5.6, 95% CI = 2.5-12.6) were significantly associated with HCV infection.

In the "restricted" multivariate model having had a blood transfusion (OR=4.4, 95% CI = 2.6-7.4), a history of IV drug use (OR=32.1, 95% CI = 15.9-65.0), prior dental or oral surgery (OR=2.3, 95% CI = 1.0-5.3), acupuncture (OR=1.7, 95% CI = 1.0-3.0), having a tattoo (OR=2.0, 95% CI = 1.1-3.7), having spent time in prison (OR=4.8, 95% CI = 1.9-12.3), and having HIV (OR=12.7, 95% CI = 1.5-111.8) were each significantly associated with HCV infection.

Table 2.— Medical, Occupational, Percutaneous and Other Exposures. Univariate analysis. Odds ratios, 95% CI, and P-values				
Variables	Cases (n=222) Number (%)	Controls (n=699) Number (%)	OR (95% CI)	P-value
Blood Transfusion				
Yes	69 (35.9)	95 (14.2)	3.4 (2.3-5.0)	0.000
No	123 (64.1)	572 (85.8)		
Hemophilia or Blood Disorder				
Yes	22 (10.3)	15 (2.3)	5.0 (2.4-10.3)	0.000
No	192 (89.7)	649 (97.7)		
Dental or Oral Surgery				
Yes	187 (90.8)	574 (83.3)	2.0 (1.2-3.4)	0.012
No	19 (9.2)	115 (16.7)		
Surgery before 1992				
Yes	113 (87.6)	257 (74.5)	2.4 (1.3-4.5)	0.003
No	16 (12.4)	88 (25.5)		
Acupuncture				
Yes	85 (38.8)	121 (18.0)	2.9 (2.0-4.1)	0.000
No	134 (61.2)	553 (82.0)		
Tattoo by a Pro				
Yes	67 (30.2)	62 (8.9	4.4 (3.0-6.7)	0.000
No	155 (69.8)	637 (91.1)		
Tattoo at Home				
Yes	32 (14.4)	13 (1.9)	8.9 (4.4-18.4)	0.000
No	190 (85.6)	686 (98.1)		
Body Piercing				
Yes	13 (6.0)	14 (2.1)	3.0 (1.3-6.9)	0.007
No	205 (94.0)	658 (97.9)		
Healthcare Workplace				
Yes	63 (29.0)	125 (18.6)	1.8 (1.2-2.6)	0.001
No	154 (71.0)	548 (81.4)		
Prison < 6 months				
Yes	42 (18.9)	15 (2.1)	10.6 (5.5-20.7)	0.000
No	180 (81.1)	684 (97.9)		
Prison 6 months +				
Yes	31 (14.0)	3 (0.4)	37.7 (10.8-157.9)	0.000
No	191 (86.0)	696 (99.6)		

Table 3.— Drug use risk factors. Univariate analysis. Odds ratios, 95% CI, and P-values.				
Variables	Cases (n=222) Number (%)	Controls (n=699) Number (%)	OR (95% CI)	P-value
IV drugs				
Yes	107 (56.0)	17 (2.6)	48.0 (26.4-88.0)	0.000
No	84 (44.0)	640 (97.4)		
Cocaine				
Yes	135 (60.8)	94 (13.4)	10.0 (6.9-14.4)	0.000
No	87 (39.2)	605 (86.6)		
Speedball (Cocaine/Heroin)				
Yes	53 (23.9)	6 (.9)	36.2 (14.5-96.1)	0.000
No	169 (76.1)	693 (99.1)		
Heroin				
Yes	110 (49.5)	19 (2.7)	35.2 (20.1-62.1)	0.000
No	112 (50.5)	680 (97.3)		
Crack Cocaine				
Yes	61 (27.5)	16 (2.3)	16.2 (8.8-30.2)	0.000
No	161 (72.5)	683 (97.7)		
Methamphetamines				
Yes	80 (36.0)	27 (3.9)	14.0 (8.5-23.3)	0.000
No	142 (64.0)	672 (96.1)		
Amphetamines				
Yes	91 (41.0)	56 (8.0)	8.0 (5.3-12.0)	0.000
No	131 (59.0)	643 (92.0)		
Steroids				
Yes	8 (3.6)	12 (1.7)	2.1 (0.8-5.8)	0.157
No	214 (96.4)	687 (98.3)		
None of the Above				
Yes	50 (22.5)	527 (75.4)	0.1 (0.06-0.14)	0.000
No	172 (77.5)	172 (24.6)		

Discussion

Overall, behaviors and exposures associated with HCV infection in Hawaii's multi-racial, multi-cultural environment are consistent with those identified among the general U.S. population.[3,8] Blood transfusions prior to 1992 and a history of intravenous drug use have been shown to be major risk factors for HCV in many studies on the mainland and elsewhere. [2,9,10]

In this study a majority (60%) of the HCV cases identified themselves as white, while a majority (63%) of the controls identified themselves as Japanese or other Asian ancestry. Studies on the US mainland suggest that race is not independently associated with HCV when the analyses control for socioeconomic status and behaviors. [11,12] Therefore, it seems more likely that the over-representation of whites among HCV cases reflects confounding by other exposures, possibly a history of prior intravenous drug use or transfusions.

Persons in the center of the age spectrum were over-represented among HCV cases. Persons aged 41-60 years at the time of this study were young adults during the late 1960s and early 1970's - a time of increased drug use.[13] It is worth noting that a majority of

Table 4.— Sexual behavior risk factors. Univariate analysis. Odds ratios, 95% CI, Yates corrected chi-square and P-values.				
Variables	Cases (n=222) Number (%)	Controls (n=699) Number (%)	OR (95% CI) or Chi-Square	P-value
Had sex with someone with hepatitis C				
Yes	27 (48.2)	17 (3.6)	25.0 (11.5-54.9)	0.000
No	29 (51.8)	457 (96.4)		
Had sex with an IV drug user				
Yes	90 (64.3)	17 (3.3)	52.9 (28.0-101.2)	0.000
No	50 (35.7)	500 (96.7)		
Gonorrhea				
Yes	43 (19.4)	35 (5.0)	4.6 (2.8-7.6)	0.000
No	179 (80.6)	664 (95.0)		
HIV				
Yes	6 (2.7)	2 (0.3)	9.7 (1.7-70.8)	0.003
No	216 (97.3)	697 (99.7)		
Syphilis				
Yes	6 (2.7)	1 (0.1)	19.4 (2.3-437.0)	0.001
No	216 (97.3)	698 (99.9)		
Chlamydia				
Yes	4 (1.8)	28 (4.0)	0.4 (0.1-1.4)	0.176
No	218 (98.2)	671 (96.0)		
Genital Herpes				
Yes	14 (6.3)	33 (4.7)	1.4 (0.7-2.7)	0.447
No	208 (93.7)	666 (95.3)		
Genital Warts				
Yes	17 (7.7)	42 (6.0)	1.3 (0.7-2.4)	0.382
No	205 (92.3)	657 (94.0)		
Number of Lifetime Sexual Partners			X2 = 94.5	0.000
0-1	8 (8.1)	151 (33.6)	reference	
2-5	18 (18.2)	168 (37.3)	2.0 (0.9-4.8)	0.109
6-15	32 (32.3)	94 (20.9)	6.4 (2.8-14.5)	0.000
>15	41 (41.4)	37 (8.2)	20.9 (9.0-48.4)	0.000

HCV cases in this study reported a history of prior IV drug use, suggesting that the age distribution observed among cases may be a result, at least in part, to historical drug use behaviors in this cohort. People aged 60 and over were over-represented among the controls.

In univariate analyses, having a blood transfusion, major surgery before 1992, prior dental or oral surgery, and a history of working in a healthcare setting were all significantly associated with HCV. However, when confounding was controlled for in the "restricted" multivariate model, major surgery before 1992 was no longer statistically associated, although blood transfusion, prior dental or oral surgery, and a history of working in a healthcare setting remained significant risk factors.

Table 5.— Restricted Multivariate Model Analysis. Including Twelve Potential Risk Factors for HCV Infection		
Variables	OR (95% CI)	P-value
IV drug use	32.1 (15.9-65.0)	0.000
HIV Infection	12.7 (1.5-111.8)	0.022
Prior Prison Stay	4.8 (1.9-12.3)	0.001
Prior Blood Transfusion	4.4 (2.6-7.4)	0.000
Dental or Oral Surgery	2.3 (1.0-5.3)	0.041
Tattoo	2.0 (1.1-3.7)	0.020
Acupuncture	1.7 (1.0-3.0)	0.042
History of syphilis	2.8 (0.2-49.8)	0.485
Hemophilia	2.5 (0.8-7.2)	0.099
History of gonorrhea	1.6 (0.7-3.6)	0.266
Health care work	1.6 (1.0-2.8)	0.072
Body piercings	1.5 (0.4-5.6)	0.505

In univariate analyses, having a tattoo was associated with HCV and the strength of this association appeared to double if the tattoo was administered in a setting outside a professional tattoo establishment, e.g. by a friend at home (OR=4.4 and 8.9, respectively). Tattooing was also significantly associated with HCV in the "restricted" multivariate analyses. Tattooing originated in the Pacific islands and the practice is a strong cultural tradition in Hawaii that dates back to the early 1800's.[14] Because of these deep cultural roots and the ceremonial nature of the traditional tattooing process, tattoos in Hawaii and other Pacific nations may be more likely to be done at home by a friend. This practice is certainly not limited to the Pacific islands, however, as a study in Canada also found that having a non-professional tattoo was a risk factor for HCV.[15] Tattooing could be a risk for HCV transmission if the tattooing instruments were used on more than one person and not sterilized between uses. Because of their cultural popularity, the issue of tattooing (both professional and non-professional) as a risk exposure for HCV warrants further investigation.

Another practice common in Hawaii, acupuncture, was reported by 39% of cases and 18% of controls. Acupuncture was statistically associated with HCV in the univariate and "restricted" multivariate analyses. However, as a medical treatment, acupuncture might have been more common among cases because of HCV-related symptoms, and not because it is a risk factor for infection. Additional HCV studies in Hawaii might further explore whether percutaneous acupuncture practices pose any risk for HCV acquisition.

Perhaps reflective of high rates of drug use, more than a third of all HCV cases in this study had spent time in prison, compared to less than 3% of the controls. While likely a surrogate for other HCV-associated exposures, prison time remained a significant predictor of HCV status in the "restricted" multivariate model and may warrant further assessment.[16]

With regard to sexually transmitted diseases, univariate analyses revealed that the most prevalent infections on a population-based level - chlamydia, genital herpes, and genital warts - were not significantly associated with HCV; however, infection with HIV, syphilis or gonorrhea were. It is possible that the latter infections are markers for sexual or other risk factors, as none of them were independently associated with HCV in the multivariate analyses. Although based on just eight infections among 921 respondents, HIV was associated with HCV in the "restricted" multivariate analysis. From our data it is not possible to discern whether this association resulted because: 1) HIV infection is a risk factor for HCV, or vice versa; 2) persons with HIV are simply more likely to be evaluated for HCV than non-HIV infected persons, or vice versa; or 3) HCV and HIV share common routes of transmission.

This study has several limitations. First, the overall response rate for the self-administered questionnaire was just over 40%. The response rate was almost identical for cases and controls, however, and not unexpectedly low given the sensitive nature of some of the questions asked. Also, some groups were over-represented in the control group, including those with college or graduate degrees (46.2% vs. 36% for cases) and those aged 60 and over (42.1% vs. 9.7% for cases). For this reason, the associations found between 1) HCV and educational level and 2) HCV and age may be misleading. Another limitation was the unacceptably low response rate to specific questions, namely, having had sex with a HCV-infected person or with an IV drug user, number of lifetime sexual partners, and surgery before 1992. We excluded these variables from consideration in the multivariate analysis because all data from respondents with a missing value in any of these four fields would necessarily be excluded. A third limitation is the case-control methodology. Case-control studies can introduce recall bias, as cases may be more apt to remember certain exposures, such as transfusions, or omit reporting others, especially those of a sensitive nature such as drug use and sexual behavior. Finally, we excluded homeless people and others without telephones because they could not be contacted or sent a questionnaire; how this might have affected the results is unknown.

Future public health efforts in Hawaii should focus on developing effective and appropriate interventions targeting those with established risk factors for HCV, specifically IV drug users and persons who received blood products prior to 1992. Community interventions should include educational prevention programs and readily accessible HCV screening. Expanding substance abuse treatment programs should help to decrease the number of people who use IV drugs and are at risk of acquiring HCV. Educational programs for persons already infected with HCV should focus on safe sex and the need to use sterile needles for those who continue to use IV drugs. In addition, needle exchange programs should be promoted among IV drug users.[17] Finally, current treatment options, including vaccination against hepatitis A and B and cessation of alcohol consumption, should be discussed with HCV cases so that they have an opportunity to mitigate the progression from hepatitis C to liver damage and maintain their quality of life. Additional research may be needed to better assess the potential role, if any, of tattooing and acupuncture in HCV transmission.

References

1. McQuillan GM, Alter MJ, Moyer LA, Lambert SB, Margolis HS. A population based serologic study of hepatitis C virus infection in the United States. In Rizzetto M, Purcell RH, Gerin JL, Verme G, eds. *Viral Hepatitis and Liver Disease*. Edizioni Minerva Medica, Turin, 1997, 267-70.
2. National Institutes of Health Consensus Statement. Management of Hepatitis C: 2002. Accessed on Nov 18, 2003 at: http://consensus.nih.gov/cons/116/09120211 6cdc_statement.htm
3. Brown, RS, Gaglio, PJ. Scope of Worldwide Hepatitis C Problem. *Liver Transplantation* 2003 November; Vol 9, No 11, Suppl 3:S10-S13.
4. Centers for Disease Control and Prevention. Recommendations for Prevention and Control of Hepatitis C Virus (HCV) Infection and HCV-Related Chronic Disease. MMWR 1998; 47(No.RR-19): 1-32.

5. Schreiber, GB, Busch, MP, Kleinman SH, Korelitz JJ. The risk of transfusion-transmitted viral infections. *N Engl J Med* 1996; 334: 1685-90.
6. Profile of General Demographic Characteristics: 2000 Data Set: Census 2000 Summary File 1. Geographic Area: Hawaii. U.S. Census Bureau. Retrieved on June 18, 2004, from: http://quickfacts.census.gov/qfd/
7. Immigration Impact; Retrieved on February 17, 2004, from Federation for American Immigration Reform web site: http://www.fairus.org/Research/Research.cfm?ID=1556&c=9
8. Stover CT, Smith DK, Schmid DS et al. Prevalence of and risk factors for viral infections among HIV-infected and high-risk HIV-uninfected women. J Infect Dis. 2003 May 1; 187(9): 1388-96.
9. Yawn BP, Wollan P, Gazzuola L, Kim WR. Diagnosis and 10-year follow-up of a community-based hepatitis C cohort. J Fam Pract 2002 Feb; 51(2): 135-40.
10. Global surveillance and control of hepatitis C. Report of a WHO Consultation organized in collaboration with the Viral Hepatitis Prevention Board, Antwerp, Belgium. Journal of Viral Hepatitis 1999; 6: 35-4.
11. Kaur S, Rybicki L, Bacon BR, Gollan JL, Rustgi VK, Carey WD. Performance characteristics and results of a large-scale screening program for viral hepatitis and risk factors associated with exposure to viral hepatitis B and C: results of the National Hepatitis Screening Survey. National Hepatitis Surveillance Group. Hepatology. 1996 Nov; 24(5): 979-86.
12. Balasekaran R, Bulterys M, Jamal MM et al. A case-control study of risk factors for sporadic hepatitis C virus infection in the southwestern United States. Am J Gastroenterol. 1999 May;94(5):1341-6.
13. Review the evolution of prevention approaches since the 1960's; Retrieved on March 15, 2004, from Mental Health Specialists web site: http://p2001.health.org/MHS01/mod2tr.htm
14. Tsai, Michael. Examining tattoos as art, culture. Honolulu Advertiser. May 1, 2003. Accessed at: http://the.honoluluadvertiser.com/article/2003/May/01/il/il04a.html
15. Nishioka Sde A, Gyorkos TW, Joseph L, Collet JP, Maclean JD. 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. 2002 Feb; 128(1):63-71.
16. Reindollar RW. Hepatitis C and the correctional population. Am J Med. 1999 Dec 27; 107 (6B):100S-103S.
17. Bonomo YA, Bowes G, Putting harm reduction into an adolescent context. J. Paediatr. Child Health 2001 37, 5–8.