

Hepatitis C Is Poorly Associated With Drug Use in Cambodian Americans in Lowell, Massachusetts

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Background. Hepatitis C (HCV) is the most common chronic blood-borne infection in the United States and affects Asian and non-Asian Americans comparably. Injection drug use, the most common national transmission risk, is not as prevalent in Asian-Americans, but prior studies do not include many Cambodian Americans. Lowell, Massachusetts has the second largest population of Cambodian Americans, allowing a direct comparison of HCV-infected Cambodian and non-Cambodian Americans not previously done. Improving our understanding of HCV risks in this unique community may improve their linkage to care.

Methods. In this cross-sectional study, medical data were collected regarding HCV risk factors for HCV-infected Cambodian and non-Cambodian Americans seen at Lowell Community Health Center from 2009 to 2012.

Results. Cambodian Americans (n = 128) were older (mean age 53 vs 43 years old) and less likely to be male (41% vs 67%, $P < .001$) compared with non-Cambodians (n = 541). Cambodians had lower rates of injection drug use (1.6% vs 33.6%, $P < .001$) and any drug use (2.3% vs 82.1%, $P < .001$). More Cambodians were born between 1945 and 1965 (66.4% vs 44.5%). Within this birth cohort, more Cambodians had no other risk factor (82% vs 69%, $P = .02$). Fewer Cambodians had chronic HCV (53% vs 74%, $P < .001$).

Conclusions. Birth between 1945 and 1965 was the major HCV risk factor for Cambodian Americans. Cambodians had lower rates of injection drug use or any drug use history. Risk behavior screening fails to describe HCV transmission for Cambodian Americans and creates a barrier to their linkage to care.

Keywords. Cambodian; hepatitis C; Lowell; risk factors; virus.

Hepatitis C virus (HCV) is the most common chronic blood-borne infection nationally [1, 2] and has potentially fatal consequences that include cirrhosis and hepatocellular carcinoma [3]. In 2008, of the 3 most common viral hepatitises (hepatitis A, B, and C), death rates were highest among persons infected with HCV (4.7 deaths per 100 000 population) [4]. From 1999 to 2007, the numbers of HCV-related deaths exceeded deaths due to human immunodeficiency virus (HIV) in the United States [4, 5]. In addition, HCV-associated liver disease remains the leading indication for liver transplant in the United States [6–8]. These are serious medical and financial burdens of HCV infection.

Although there are few estimates of HCV prevalence specifically in Cambodian Americans, prevalence rates vary from 1.2% to 6% in studies examining HCV in Asian Americans of

multiple ethnicities, mostly non-Cambodian [4, 9, 10]. In comparison, HCV prevalence in the United States is 1.3% according to the most recent data from the third National Health and Nutrition Examination Survey (NHANES III) [1, 11, 12]. These NHANES data do not have numbers for Asian Americans. Thus, Asian Americans may carry higher rates of HCV infection compared with the rest of the United States, and the lifelong consequences of HCV are serious, but HCV remains poorly understood in this group. Our study of HCV risk is needed because information regarding HCV risk in Asian Americans and Cambodian Americans is lacking despite the seriousness of infection.

Specific HCV transmission risks can greatly differ in different population groups. The major HCV risk in the United States is intravenous drug use [3, 13–16]. However, in many developing countries, the most frequently identified mode of HCV transmission is poor hygiene in medical practices [17], and intravenous drug use is not as prominent a risk factor [15, 18, 19].

Studies have found that HCV-infected Asian Americans, whether of Cambodian origin or not, have rates of drug use that are less than 4% [18, 19], compared with 43%–60% among HCV-infected non-Asian Americans [18, 19]. These studies suggest that a more important source of transmission in Asian Americans may be previous “unsafe therapeutic injections” [18, 19]. Although these studies have not included Cambodian Americans

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in large numbers [9–11, 18, 19], they do suggest that transmission risks may differ greatly between Cambodian Americans and non-Cambodian Americans. Lowell, Massachusetts has the second largest population of Cambodian Americans in the United States [20, 21]. This provides an opportunity to examine the risks for hepatitis C transmission among Cambodian Americans in a study that is larger than previously published [4, 9, 10, 18, 19].

The objective of this study is to assess the risk factors associated with HCV in a population of infected Cambodian Americans compared with infected non-Cambodian Americans, all of whom are receiving care in a large urban health center. An incomplete understanding of HCV risk can be a barrier in linkage to care. Cambodian American adults who have HCV may have different rates of nationally recognized HCV risk factors compared with infected non-Cambodian Americans. It is crucial to recognize and understand transmission risks in all populations for disease identification to be more complete. A more comprehensive understanding of HCV transmission patterns could apply to the general population and not only Cambodian Americans.

METHODS

Study Setting

Lowell, Massachusetts is an urban city with high rates of drug use and the second largest population of Cambodian Americans in the United States [20–22], facilitating the study of risk factors in 1 focused area. Annually, approximately 47 000 people in the greater Lowell area receive services from Lowell Community Health Center (LCHC), and over 26 000 of them receive primary medical care. Many of the individuals seen at LCHC are of low income (see Table 1) [23]. The community health center has a number of clinical departments, including Adult Medicine, Family Medicine, Pediatrics, Obstetrics-Gynecology and Family Planning, Behavioral Health, and the Metta Health Center, a clinical site that focuses on Southeast Asian and newly arrived refugee communities. Approximately 28% of the patients seen annually at LCHC self-identify as Cambodian.

Study Sample and Collection

This is a cross-sectional study of HCV-infected adults receiving care at LCHC who were tested for HCV between 2009 and 2012. Figure 1 shows how the study sample was collected.

The system-wide electronic medical records of LCHC, stored in eClinical Works software, was searched for adults over the age of 18 years old who underwent HCV antibody or ribonucleic acid (RNA) testing between January 1, 2009 and December 31, 2012. This resulted in an initial sample size of 4541 adults.

From this group of 4541 adults, 1256 individuals identified as Cambodian in their medical record. The medical data were then reviewed for HCV antibody or RNA virus testing. Individuals were considered HCV infected if their medical record had positive results for HCV antibody or HCV RNA testing. Positive

Table 1. Description of Lowell Community Health Center

Lowell Community Health Center		
Screened for HCV		
Cambodian (n = 1256)	Average age: 46.16 ± 15.04 y old	45% men
	Range: 18–92 y	
Non-Cambodian (n = 3285)	Average age: 38.75 ± 13.1 y old	53% men
	Range: 18–87 y	
Patients seen from 2009 to 2012		
Asian (n = 20 669)		
General (n = 79 288)		
Total patients served (2014) ^a	26 085	
Gender of Patients (n = 26 085) ^a		
Women (under 15 y old)	24.9%	
Women (15–64 y old)	69.1%	
Women (65 y and over)	6.9%	
Men (under 15 y old)	36.7%	
Men (15–64 y old)	58.1%	
Men (65 y and over)	5.2%	
Income Status ^a		
Patients at or below 200% poverty	94.2%	
Patients at or below 100% poverty	73.4%	
Uninsured	5.5%	
Medicaid/CHIP	71.5%	

Abbreviations: CHIP, Community Health Information Profile; HCV, hepatitis C virus.

^a Gathered from Health Resources and Services Administration 2014 Health Center Profile [23].

results for either antibody or RNA tests were verified for 128 individuals, so they were included in the study as Cambodian American HCV-infected adults.

The rest of the 3285 individuals were non-Cambodian Americans. By medical data review, HCV infection was verified by positive HCV antibody or RNA virus results in 541 individuals,

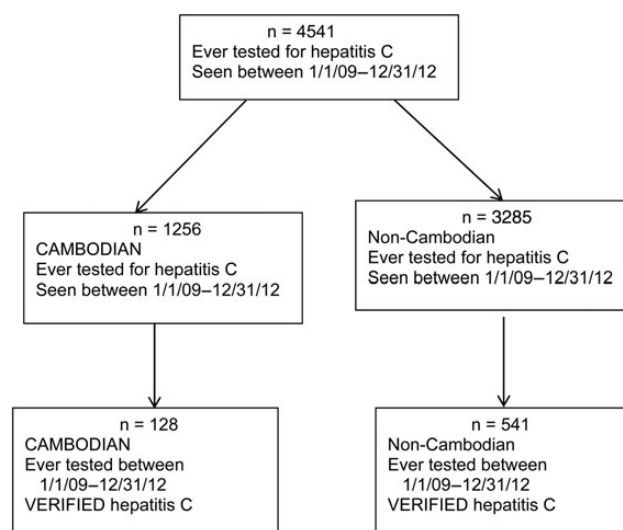


Figure 1. Flowchart of study sample collection.

Table 2. HCV Risk Factors by Professional Groups

Group		
AASLD/IDSA/IAS-USA [24, 25]	CDC [2, 15, 26]	USPSTF [27]
Intravenous drug use	Intravenous drug use	Intravenous drug use
Born between 1945 and 1965 *Added to this guideline 2015 [24]	Born between 1945 and 1965 *Added to this guideline August, 2012 [15]	Born between 1945 and 1965 *Added to this guideline June 2013 [27]
Transfusion or transplant Donor later test + HCV Before July 1992 Clotting factor before 1987	Transfusion or transplant Donor later test + HCV Before July 1992 Clotting factor before 1987	Blood transfusion before 1992
Long-term hemodialysis	Long-term hemodialysis	Long-term hemodialysis
Birth to HCV+ mother	Birth to HCV+ mother	Birth to HCV+ mother
Healthcare, emergency medical, public safety worker after needle stick, sharp, or mucosal exposure to HCV	Healthcare, emergency medical, public safety worker after needle stick, sharp, or mucosal exposure to HCV	Percutaneous exposure (Healthcare workers, Surgery before universal precautions)
Incarceration		Incarceration
Intranasal drug use		Intranasal drug use
Tattoo in unregulated setting		Tattoo in unregulated setting
Persistently abnormal ALT	Persistently abnormal ALT	
HIV	HIV	

Abbreviations: AASLD, American Association for the Study of Liver Diseases; ALT, alanine transaminase; CDC, Centers for Disease and Prevention; HCV, hepatitis C virus; HIV, human immunodeficiency virus; IAS-USA, International Antiviral Society-USA; IDSA, Infectious Disease Society of America; USPSTF, US Preventive Service Task Force. * Date at which the 1945 to 1965 birth cohort was added to this risk factor guideline.

and they were included as non-Cambodian American HCV-infected adults.

Variables of Interest

Risk Factors

The primary outcome of this study was differences between Cambodian and non-Cambodian Americans in HCV transmission risks. The 3 major sets of US guidelines that identify risk factors for HCV transmission have been issued by the following: (1) the American Association for the Study of Liver Diseases (AASLD), Infectious Diseases Society of America (IDSA) and the International Antiviral Society-USA (IAS-USA) jointly [24, 25], (2) the Centers for Disease Control and Prevention (CDC) [2, 15, 26], and (3) the US Preventive Services Task Force (USPSTF) [27] (see Table 2). This study takes place at a Community Health Center where providers are more likely to follow USPSTF guidelines than the more specialty-oriented AASLD/IDSA/IAS-USA or CDC guidelines. It was believed that the USPSTF risk factors would be adequate in this study. In addition, no 1 guideline differs greatly from the others because they overlap considerably.

The risk factors used in this analysis were as follows: (1) history of intravenous drug use, (2) year of birth between 1945 and 1965, (3) history of hemodialysis, (4) previous work in any healthcare field, (5) prior or current sexual partner with hepatitis C, (6) history of maternal infection with hepatitis C, and (7) history of transfusions of blood products. These encompass the risk factors shared by the guidelines (Table 2).

Information regarding dialysis and previous transfusions were gathered from the medical and surgical history sections of the electronic medical record where the individual would

have reported this history. The social and family histories were reviewed for any patient-reported history of any drug use, intravenous drug use, any previous employment history, maternal HCV infection, and prior sexual partner histories.

The USPSTF recognized HCV risk factors of intranasal drug use, incarceration, and tattoos in unregulated settings were not included as outcome variables because their documentation in the medical records was poor.

Patient Characteristics

Patient characteristics abstracted from the medical record were as follows: patient's age at the time of hepatitis C testing, year of birth, gender, need for translator service, any drug use, hepatitis B infection, and chronic HCV infection. The year of birth and gender were collected from the electronic medical record. The age at the time of testing was derived from the year of birth. A need for translator services was self-reported by the patient in the medical record. Hepatitis B infection was determined by the presence of hepatitis B surface antigen positivity. As noted above, patient-reported use of intravenous drug use or any drug use was gathered from the social history section of the medical record.

Chronic infections were defined as having persistent viremia for at least 6 months [24–28]. This was determined by the presence of HCV RNA positive results.

Covariates

Potential covariates were the presence of HIV infection, alcohol use, and elevated aminotransferase levels on laboratory testing. These variables were not USPSTF risk factors [27], and they

were studied as potential confounders instead of outcome variables.

Human immunodeficiency virus status was evaluated by HIV test results in the laboratory records. Alcohol use was assessed by patient-reported use in their medical record Social History. This was defined as excess alcohol use or more than 14 drinks per week, the definition of at-risk drinking [29–31]. Aminotransferase levels were measured with alanine aminotransferase (ALT) testing. These values were gathered from medical record laboratory results. The single maximum ALT result for each individual was totaled and averaged for both groups. In addition, the numbers of individuals with maximum ALT levels greater than 40 IU/L were compared to evaluate which group had more individuals with measureable liver inflammation. The ALT level of 40 IU/L has been recognized as an upper limit for normal liver function by national groups [25, 32, 33].

Data Analysis

Each risk factor was compared by univariate analysis between Cambodian and non-Cambodian American groups. These statistics were performed with R and SAS statistical software [34, 35]. Due to the small numbers in some risk factor categories, Fisher's exact test was used for analysis of categorical data. Welch's *t* test was used to evaluate nonnormal continuous variables and patient characteristics.

Multivariable regression analysis was not done because there was no dependent outcome variable that could be evaluated. Injection drug use rates were so low in Cambodians that this could not be evaluated as an outcome. Hepatitis C virus and birth years could not act as dependent outcomes either. Hepatitis C virus was present in all individuals and would not have varied by independent factors, whereas a birth year would not have depended on another transmission factor.

RESULTS

Study Sample

Table 3 compares the Cambodian and non-Cambodian study samples. Hepatitis C virus-infected Cambodian adults were older and predominantly female. The average overall age of Cambodians was significantly higher than that of non-Cambodian adults (52.6 vs 42.8 years, $P < .001$). The non-Cambodian HCV-infected adults' ages had a nonnormal distribution with a peak in the mid 30-year-olds and another peak at the early 50-year-olds (Figure 2). Only 28% infected non-Cambodians were less than 35 years old at the time of testing. In contrast, the ages of Cambodian adults were distributed normally around the mean, and only 9% of this group of individuals were younger than 35 years old.

There were significantly more HCV-infected Cambodian women (58% vs 41%), whereas the non-Cambodian group was composed of more men than women: 66.5% men and 33.5%

Table 3. Patient Characteristics and Covariates (N = 669 Patients in Care With HCV)

Characteristics	Cambodian (n = 128)	Non-Cambodian (n = 541)	P Value
Ethnicities			
White, non-Hispanic	0 (0%)	310 (57.3%)	
Hispanic	0 (0%)	196 (36.2%)	
Black	0 (0%)	21 (3.9%)	
Asian	128 (100%)	13 (2.4%)	
Unspecified	0 (0%)	1 (0.2%)	
Age			
Mean	52.57	42.75	.001
SD	12.33	11.07	
Minimum	19	19	
Maximum	90	78	
Gender			
Male	53 (41.4%)	360 (66.5%)	.001
Female	74 (57.8%)	181 (33.5%)	
Transgender	1 (0.8%)		
Translator need			
Yes	117 (91.4%)	75 (13.9%)	.001
No	11 (8.6%)	466 (86.1%)	
Unknown	0 (0%)	0 (0%)	
Chronic Infection			
Yes	68 (53.13%)	399 (73.75%)	.001
No	52 (40.63%)	84 (15.53%)	
Unknown	8 (6.25%)	58 (10.72%)	
Genotype			
1	47 (36.7%)	156 (28.8%)	
2	3 (2.3%)	25 (4.6%)	
3	0	41 (7.6%)	
4	0	5 (0.9%)	
6	10 (7.8%)	0	
Hepatitis B			
Yes	6 (4.69%)	8 (1.48%)	.109
No	107 (83.59%)	355 (65.62%)	
Unknown	15 (11.72%)	178 (32.90%)	
Drug Use			
Yes	3 (2.3%)	444 (82.1%)	.001
No	125 (97.7%)	97 (17.9%)	
HIV Infection			
Positive	4 (3.13%)	60 (11.09%)	.47
Negative	23 (17.97%)	212 (39.19%)	
Untested	101 (78.91%)	269 (49.72%)	
Maximum ALT (IU/L)^a			
Mean	91.28	131.50	.001
SD	95.14	200.5	
Minimum	14	14	
Maximum	852	2052	
Unknown	0	20	
ALT greater than 40 IU/L			
Yes	93 (72.66%)	419 (77.45%)	.07
No	35 (27.34%)	103 (19.04%)	
Unknown		19 (3.51%)	
Excessive Alcohol Use^b			
Yes	15 (11.7%)	217 (40.1%)	.001
No	110 (85.9%)	291 (53.8%)	
Unknown	3 (2.3%)	33 (6.1%)	

Abbreviations: ALT, alanine transaminase; HCV, hepatitis C virus; HIV, human immunodeficiency virus; SD, standard deviation.

^a Single maximum ALT recorded (see Methods: Covariates).

^b Any history of excessive alcohol use (see Methods: Covariates).

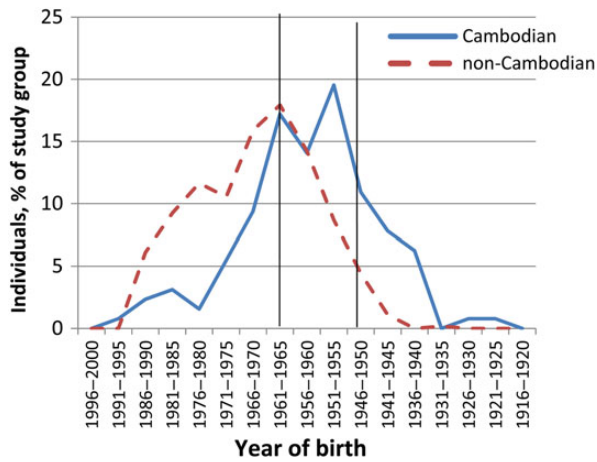


Figure 2. Distribution of years of birth at the time of HCV testing.

women. Many more Cambodian American adults needed a translator (91.4% vs 13.9%, $P < .001$).

Ten Cambodian adults had genotype 6 HCV infection, a viral genotype absent in non-Cambodians in this study. No genotype 3 or 4 infection was found in these Cambodian Americans.

Covariates

There were no differences in the rates of HIV between these groups. However, many Cambodian adults reported no HIV results.

The average ALT was greater in non-Cambodian individuals (132 IU/L vs 91 IU/L, $P = .001$). More non-Cambodians had ALT levels greater than 40 IU/L, a finding that approached statistical significance (72.66% vs 77.45%, $P = .07$). More non-Cambodians had chronic HCV infection (73.75% vs 53.13%, $P < .001$), and rates of alcohol use were higher for non-Cambodian adults (40.1% vs 11.7%, $P < .001$).

Risk Factors

Table 4 compares the risk factors measured in this study. At least 1 risk factor was identified in only 68.6% of non-Cambodians and in 75.8% of Cambodians. Significantly lower rates of

injection drug use were found in Cambodian individuals (1.6% vs 33.6%, $P < .001$; see Table 3). There were also significantly more HCV-infected Cambodian adults born between 1945 and 1965 than non-Cambodians (66.4% vs 44.5%, $P < .001$).

Prior healthcare work, sexual exposure, and maternal history of infection were reported in small numbers of individuals, but these had statistically significant findings. Significantly more Cambodians reported prior employment in healthcare (6.25% vs 0.6%, $P < .001$), any prior sexual exposure to HCV (4.7% vs 1.5%, $P = .034$), and a maternal history of HCV infection (3.1% vs 0.7%, $P = .048$). Rates of transfusion and of hemodialysis were low and were not significantly different between the groups.

Significantly more non-Cambodian Americans had 2 or more HCV risk factors (21.6% vs 11.7%, $P = .01$). None of the Cambodians with 2 or more risk factors had a history of injection drug use, and 93.3% had the birth cohort as 1 of the multiple risk factors.

There was no difference between non-Cambodians and Cambodians with 1 or more risks (68.6% vs 75.8%, $P = .13$). Among individuals with 1 or more risk factors, more Cambodian Americans were born between 1945 and 1965 (87.6% vs 62.9%, $P < .001$) and more non-Cambodian Americans reported intravenous drug use (49.1% vs 2.1%, $P < .001$).

DISCUSSION

Major Risk Factors

Injection drug use was not a major HCV risk factor for infected Cambodians seen at LCHC between 2009 and 2012. Fewer than 2% of these HCV-infected Cambodian Americans had any history of injection drug use. This low rate is consistent with other studies of HCV-infected Asian Americans that demonstrated injection drug use rates of 3.1%–11%. These studies did not include many Cambodian Americans, so our study adds to this literature and supports the hypothesis that injection drug use does not explain HCV infection in this group of Asian Americans [9, 18, 19].

At least 1 risk factor was identified in 68.6% of non-Cambodians and in 75.8% of Cambodians. Current risk factors

Table 4. Risk Factors, Cambodian and Non-Cambodian

Risk Factors	Cambodian (n = 128)			Non-Cambodian (n = 541)			P Value
	Yes	No	Unknown	Yes	No	Unknown	
Born between 1945 and 1965	85 (66.4%)	43 (33.6%)	0 (0%)	241 (44.5%)	300 (55.5%)		.001
Intravenous drug use	2 (1.6%)	115 (89.8%)	11 (8.6%)	182 (33.6%)	93 (17.2%)	266 (49.2%)	.001
Transfusion	5 (3.9%)	29 (22.7%)	94 (73.4%)	9 (1.7%)	13 (2.4%)	519 (95.9%)	.16
Hemodialysis	0 (0%)	12 (9.4%)	116 (90.6%)	1 (0.2%)	3 (0.6%)	537 (99.3%)	.2
History of work in healthcare	8 (6.25%)	96 (75%)	24 (18.8%)	3 (0.6%)	154 (28.4%)	384 (71.0%)	.001
Sexual exposure	6 (4.7%)	21 (16.4%)	101 (78.9%)	8 (1.5%)	76 (14.0%)	457 (84.5%)	.03
Family history, maternal	4 (3.1%)	115 (89.8%)	9 (7.0%)	4 (0.7%)	493 (91.1%)	44 (8.1%)	.048
One or more risk factors	97 (75.8%)	31 (24.2%)		371 (68.6%)	170 (31.4%)		.13
Two or more risk factors	15 (11.7%)	113 (88.3%)		117 (21.6%)	424 (78.4%)		.01

cannot describe how many became infected. Instead of injection drug use, the predominant risk factor for both groups was birth between 1945 and 1965. No other risk factor was identified for 82% Cambodians within this cohort. The current HCV risk factors are inadequate in describing HCV transmission. This is a pronounced barrier to care for Cambodians and for the 24% non-Cambodians born between 1945 and 1965 with no other identifiable risks. Without linkage to care, these individuals are at risk of long-term HCV complications. This study strongly supports identification of birth between 1945 and 1965 as a risk factor. It also suggests that the current testing recommendations need to be broadened to identify infected individuals with no identifiable HCV risks.

The need for translator services was a marker for a poor understanding of English and a language barrier to healthcare. Most individuals who needed a translator were immigrants who could have been exposed to unsafe medical injections. Infection control in Cambodia can be poor in large hospitals, and most healthcare is provided in small, unregulated rural clinics [36, 37]. Significantly more Cambodian Americans needed translator services (91.4% vs 13.9%), suggesting they had exposure to these healthcare practices and this serious risk of HCV infection.

There are few comprehensive studies on HCV risk factors in Cambodia. It is challenging, then, to provide a background of Cambodian-Americans' risks in their native country. A few studies suggest medical procedures are greater risks, not injection drug use. One study of HCV/HIV-coinfected Cambodians described the following risk factors: at least 5 medical injections annually, intravenous infusions before 2000, surgery, fibroscopic procedures, and blood transfusions [36]. This reflects mostly noninjection drug use-related HCV risks in Cambodia. Other studies of Asian Americans also showed greater rates of blood transfusions, acupuncture, and contaminated needle exposure in HCV-infected individuals. These studies demonstrated a 3% injection drug use rate [38, 39]. These are findings consistent with our study's data.

Hepatitis C virus-infected Cambodian Americans in our study were older and as likely to be women as to be men. In the general US population, more men are HCV infected (>60%) [4], and acute HCV is decreasing in all age groups except young injection users [4, 14]. However, other studies of HCV-infected Asian Americans noted an average age of 57–62 years old and a gender proportion of 54%–58% men [18, 19]. Thus, our study shows that Cambodian-Americans with HCV, like infected Asian Americans, are older and more likely to be women compared with non-Asian HCV-infected Americans. These are findings suggested by the current literature but not previously demonstrated.

Other Considerations

Non-Cambodian Americans had significantly higher rates of excess alcohol use and a higher average maximum ALT. In

contrast, there was no significant difference in rates of elevated ALT levels (72.66% vs 77.45%, $P = .07$). Non-Cambodian Americans, then, had higher ALT elevations than Cambodians. They also had higher rates of alcohol use and chronic HCV infection, which could have been associated with the greater level of hepatocyte inflammation reflected in ALT levels. Excess alcohol use was the only confounder that achieved significantly greater rates in 1 group. However, the difference in rates of injection drug use was so profound that it is unlikely this mild difference in alcohol use (11.7% vs 40.1%, $P < .001$) acted as a confounder.

Limitations of the Study

Recall bias is a concern in any medical data review [40]. Hepatitis C virus risk factors include socially stigmatized behaviors that can be difficult to discuss. Only 33% non-Cambodians reported injecting drugs when 88% reported ever using drugs. This difference could be due to underreporting. However, our 33% rate does not differ greatly from the most recent *MMWR* [41] reports of 38%–54% injection drug use rates in US HCV cases. Only 2.3% of Cambodians reported any drug use. Because so few Cambodians ever used drugs, any limitation from this underreporting was not of sufficient magnitude to affect our findings.

Another potential limitation was the absence of age or gender matching between the groups. Our Cambodian American group was older and included more women. This finding would have been hidden if the groups were matched. The populations, as gathered, provided all confirmed HCV-infected Cambodian and non-Cambodian Americans seen at LCHC from 2009 to 2012. Keeping the groups unmatched was not a limitation and improved the study's accuracy.

A potential threat to validity is that these findings reflected HCV-testing patterns and not true infection risk. This was not designed as a screening study, but a review of the initial 1256 Cambodians and 3285 non-Cambodians showed that our findings were not just a reflection of LCHC screening practices. In this initial group, Cambodians had an average age of 46 years, and non-Cambodians had an average age of 39 years. This confirms that those who had HCV were older than the individuals initially tested ($P < .001$) in both the Cambodian and non-Cambodian groups. Compared with these initial groups, significantly greater proportions of HCV-infected non-Cambodians were men, whereas only 45% of the initially screened non-Cambodian group was male. There was no difference in the proportion of Cambodian men who were tested and those who had HCV. The factors that place Cambodian Americans at risk of HCV affect men and women equally, whereas non-Cambodian men are disproportionately at risk of HCV. Institutional Review Board approval of this study only permitted collection of data for HCV-infected individuals, so rates of drug use in these initially tested groups are unknown.

Because this was a study of HCV-infected adults, no individuals younger than 18 years old were included. This is a potential

limitation because most of the injection drug use driving HCV infection in Massachusetts is found in younger individuals [14]. The effect of this limitation applies to both groups of HCV-infected adults, so it would have affected the outcome equally to Cambodians and non-Cambodians. However, it is an area of great interest for future study.

Aminotransferase levels were measured with ALT testing, the marker of liver inflammation specified in the AASLD guidelines [31, 42, 43] and used by the CDC for acute hepatitis identification [41]. However, the ALT has limits. Other measures of liver injury, such as the aspartate aminotransferase (AST) to platelet ratio index (APRI) score, are preferred when estimating liver fibrosis [44]. The APRI score is calculated and needs measurements of the platelet count and the AST level. This was not available for all individuals. The ALT as a single measure measures liver inflammation suboptimally, and this may have been a limitation.

Areas for Further Study

Rates of HCV and injection drug use in young Cambodian Americans are unknown and need further study. In Massachusetts, injection drug use in 15–24 year olds contributes strongly to HCV infection [14]. Screening younger Cambodian Americans would better assess the accuracy of our findings that few Cambodian individuals 20–30 years old have HCV infection.

To explore obscure modes of percutaneous viral transmission, a detailed inquiry is needed regarding medical procedures, healthcare work, traditional medical treatments, and sexual exposures that might have contributed to their HCV infection.

CONCLUSIONS

Hepatitis C is a devastating chronic viral infection. Injection drug use failed to describe HCV transmission in Cambodian Americans, and this compromised their medical care. Significantly more Cambodian Americans had only birth between 1945 and 1965 as their HCV risk. A lack of recognizable HCV risk factors can be a barrier to care and place individuals at risk of HCV complications if their infection is unrecognized. The current literature about HCV in Asian Americans lacks details about Cambodian Americans and risks that are not drug use. This study demonstrates that HCV risks are not the same in all American subpopulations. Instead of testing guided by risk assessment, screening may be critical to bring HCV-infected individuals to care.

Acknowledgments

Potential conflicts of interest. All authors: No reported conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest.

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