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Hepatitis C in Yolo County, 2000-2015

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

- 200 to 250 persons have been newly diagnosed with chronic hepatitis C virus (HCV) infection in Yolo County each year since 2008.
- Nearly 2,800 persons have been diagnosed with chronic HCV from January 2000 to August 2015. An additional 234 cases were diagnosed since between August 31, 2015 and August 15, 2016.
- About 3 men will be diagnosed with chronic HCV for each 2 women.
- Over one-third of cases were aged 50 to 59 at the time of diagnosis and the average age at diagnosis was 50 years old.
- A lower than expected proportion of Asians and Hispanics were infected with chronic HCV than are represented in Yolo County's population. A higher proportion of persons of Non-Hispanic or other races were infected with chronic HCV.
- 412 persons (14.8% or more than 1 in 7) persons with chronic HCV died between 2000 and 2015.
- Most deaths were premature (before age 75) with an average age at death of 59 years old.
- HCV prevalence (the number of chronic cases per 100,000 persons) was higher in northern parts of the city of West Sacramento, in two census tracts on the north and west sides of Woodland, and in northern rural areas of the county.
- Chronic HCV infection prevalence by census tract was correlated with a higher percentage of adults aged 25+ living in poverty in the same census tracts.

INTRODUCTION

Hepatitis C Virus (HCV) Incidence and Prevalence of chronic HCV infection in the United States

Approximately 2.7 million persons in the United States have chronic HCV infection, of whom about 500,000 live in California.[1] Infection is 5 times more prevalent among the baby boomers, persons born between 1945 and 1965, than any other age group.[2] Most HCV-infected persons were infected during the 1970s and 1980s before more advanced tests to detect HCV in the blood supply were available.

The number of new acute cases of HCV reported in the US increased from 1,778 in 2012 to 2,138 in 2013.[1] The National Institutes of Health estimates that 30,000 HCV infections actually occur each year but only 25% to 30% of them are diagnosed.[3] This means that 65% to 70% of infected persons remain unaware of their HCV infection status and are not receiving the necessary care and treatment. HCV infection therefore remains undetected for years before manifesting as end-stage chronic liver disease, cirrhosis (scarring of the liver) and liver cancer.

Annual costs nationwide for persons with HCV are expected to increase from $30 billion (in 2007) to $85 billion over the next 20 years.[4] In California alone in 2007, HCV hospitalization costs totaled $1.6 billion.[5] Research has shown that compared with other patients of similar age and sex, managed-care enrollees with HCV are hospitalized more frequently than those without HCV (24 percent for HCV-infected persons versus 7 percent for other patients).[6]

HCV infection becomes chronic in approximately 75%–85% of cases. Few persons can clear the virus from their bodies without treatment. Prior infection with HCV does not protect against later infection with the same or a different genotype. A person infected with HCV mounts an immune response to the virus, but the virus is able to evade the immune response due to changes in the virus during infection. For this reason, no effective pre- or post-exposure treatment (i.e., immune globulin) is available. Drugs are available, however, to reduce viral loads and mitigate the destructive effects of the chronic HCV infection on the liver.

Consequences of HCV Infection

Of every 100 persons infected with HCV, approximately:

- 75–85 will go on to develop chronic infection.
- 60–70 will go on to develop chronic liver disease.
- 5–20 will go on to develop cirrhosis over a period of 20–30 years.
- 1–5 will die from the consequences of chronic infection (liver cancer or cirrhosis).

Chronic HCV infection is the leading indication for liver transplants in the United States and one of the top causes of liver cancer.[7,8]

HCV Mortality

A recent Centers for Disease Control and Prevention (CDC) analysis of death certificate data found that HCV-attributable deaths increased significantly between 1999 and 2007. CDC estimated that there were 15,106 deaths due to HCV in 2007.[9]

TRANSMISSION AND SYMPTOMS

HCV Transmission

HCV is transmitted primarily through large or repeated percutaneous (i.e., passage through the skin) exposures to infectious blood, such as:

- Injection drug use (currently the most common means of HCV transmission in the United States).
- Receipt of donated blood, blood products, and organs (once a common means of transmission but now rare in the United States since blood screening became available in 1992).
- Needle stick injuries in healthcare settings.
- Birth to an HCV-infected mother.

HCV can also be spread **infrequently** through:

- Sex with an HCV-infected person.
- Sharing personal items contaminated with infectious blood, such as razors or toothbrushes.
- Invasive healthcare procedures when improperly sterilized instruments were used (usually recognized in the context of outbreaks).

Risk Factors for HCV Infection

The following persons are at known to be at increased risk for HCV infection:

- Current or former injection drug users (IDUs), including those who injected only once many years ago.
- Recipients of clotting factor concentrates made before 1987, when more advanced methods for manufacturing those products were developed.
- Recipients of blood transfusions or solid organ transplants before July 1992.
- Chronic hemodialysis patients.
- Inmates of correctional facilities.
- Persons born between 1945 and 1965.
- Military veterans, especially those who served in the Vietnam War.
- Persons with known exposures to HCV, such as healthcare workers after needle sticks from HCV-positive blood and recipients of blood or organs from a donor who later tested HCV-positive.
- Persons with HIV infection.
- Babies born to HCV-positive mothers.

Prevalence of HCV infection among Injection Drug Users (IDUs)

The most recent surveys of active IDUs indicate that approximately one-third of young (aged 18–30 years) IDUs are HCV-infected. Older and former IDUs typically have a much higher prevalence (approximately 70%–90%) of HCV infection, reflecting the increased risk of continued injection drug use. The high HCV prevalence among former IDUs is largely attributable to needle sharing during the 1970s and 1980s, before the risks of blood-borne viruses were widely known and before educational initiatives were implemented.

What is the risk of acquiring HCV infection from transfused blood or blood products in the United States?

Now that more advanced screening tests for HCV are used in blood banks, the risk is considered to be less than 1 chance per 2 million units transfused. Before 1992, when blood screening for HCV became available, blood transfusion was a leading means of HCV transmission.

Symptoms of Acute Infection

Most patients with newly acquired HCV infection are asymptomatic or have mild symptoms that are unlikely to prompt a visit to a health care professional. When symptoms occur, they can include:

- Fever
- Fatigue
- Dark urine
- Clay-colored stool
- Abdominal pain
- Loss of appetite
- Nausea
- Vomiting
- Joint pain
- Jaundice

Approximately 20%–30% of those newly infected with HCV experience fatigue, abdominal pain, poor appetite, or jaundice. The average time period from exposure to symptom onset is 4–12 weeks (range: 2–24 weeks). The early symptoms of infection usually go unrecognized.

Signs and symptoms of Chronic HCV Infection

Most persons with chronic HCV infection are asymptomatic. However, many have chronic liver disease, which can range from mild to severe, including cirrhosis and liver cancer. Chronic liver disease in HCV-infected persons is usually insidious, progressing slowly without any signs or symptoms for decades. In fact, HCV infection is often unrecognized until asymptomatic persons are identified as HCV-positive when screened after blood donation or when elevated alanine aminotransferase (ALT, a liver enzyme) levels are detected during routine medical examinations.

METHODS

Case Data and Classification

All chronic HCV cases with a diagnosis or first report date between January 1, 2000 and August 31, 2015 were included in the analysis. Cases recorded in an earlier database and not already existing in the California Reportable Disease Information Exchange (CalREDIE) database were entered in CalREDIE prior to extracting case data, including their date of first diagnosis or positive lab report. Consistent with California Department of Public Health (CDPH) disease reporting guidelines, cases lacking residence information were assigned to the county where the facility address of the health care provider ordering the laboratory tests was located. Cases in the earlier database currently residing in other counties were excluded. The extracted line list was reviewed by patient last and first names to eliminate duplicates (approximately 50). In addition, deceased cases with a date of death in the study time period that were recorded in the earlier database, or deceased cases identified from the Vital Records Business Information System (VRBIS) death records matching existing CalREDIE cases, were included in the analysis. Deceased cases were found by searching for patient names in the VRBIS data file. The cause of death and notation of chronic HCV as a contributing cause or significant underlying condition was recorded in the case notes in the CalREDIE database.

Chronic HCV cases were defined as confirmed (HCV antibody titer >11.0 or identification of viral DNA in a blood sample); probable (medical provider report without documentation of laboratory results), suspect (HCV titer ≤11.0, unspecified titer, or viral DNA below detectable threshold with no additional confirmatory laboratory tests), and previously reported (matching name and date of birth to a patient in the earlier database, or medical provider notation of an earlier date of diagnosis).

Population Data Sources

Population data for the purpose of calculating rates (per 100,000 persons) and the proportion of different racial and ethnic groups in the population were obtained from the California Department of Finance (DOF) population tables posted in 2013 at (http://www.dof.ca.gov/research/demographic/dru/index.php). For the years of the 2000 decade prior to 2010, the DOF intercensal population estimates were used. Cases were classified as Hispanic if their ethnicity was reported as Hispanic and their race as unknown, White or other.

Geographic population data at the census tract level was sourced from the latest US Census American Community Survey (ACS) five-year estimates (2009 to 2013), Table S0101, which was published in December 2014 at http://www.factfinder.census.gov. The percentage of the population below 100% of the federal poverty level (FPL) was obtained from ACS Table DP02. Persons under 25 were excluded from the population below 100% of FPL to exclude young adult students who are concentrated in the city of Davis. Furthermore, the vast majority of chronic HCV cases are diagnosed in persons over the age of 25.

Statistical Analysis

Mean, median and standard deviation were calculated in Microsoft Excel (Office 2013). Linear trends were evaluated using R-squared (ρ^2), the coefficient of determination, with values ≥0.70 suggesting a

significant linear trend. The correlation coefficient (ρ) was used to evaluate the association between chronic HCV prevalence and poverty level at the census tract level.

CASE INCIDENCE AND DEMOGRAPHICS

In Yolo County, 2,756 cases of HCV were reported or diagnosed between 2000 and August 31, 2015. An additional 23 deceased cases with diagnoses prior to 2000 were reported during this period. Thus, the percentage of the Yolo County 2015 population infected with chronic HCV is about 1.3%, which is the same as the nationwide prevalence of 1.3% estimated from the National Health and Nutrition Examination Survey (NHANES).[11]

The rate of newly diagnosed or reported cases per 100,000 persons has ranged from 40 to 150 cases per 100,000 persons between 2008 and 2015, with no significant linear trend during these years (Figure 1). The rate between 2008 and 2015 is about double the rate between 2000 and 2007. Testing for HCV became more widespread after 2007, possibly resulting in greater recognition of cases thereafter.

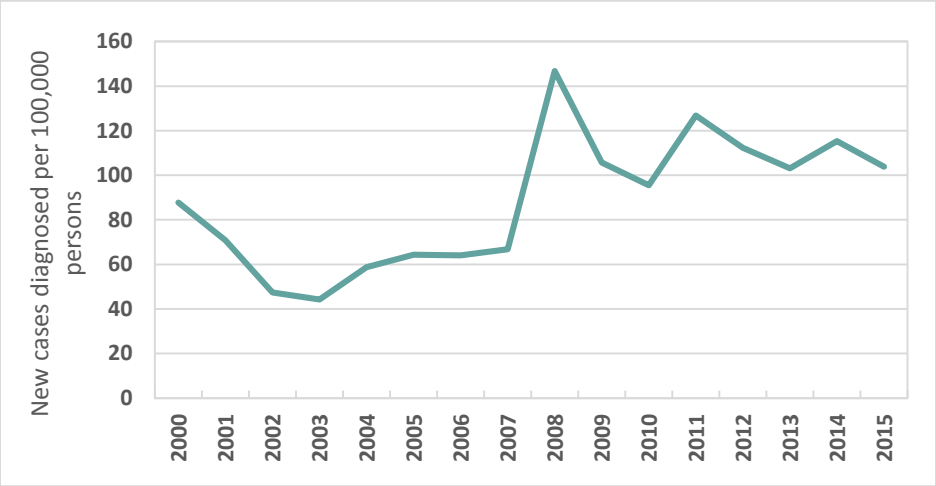
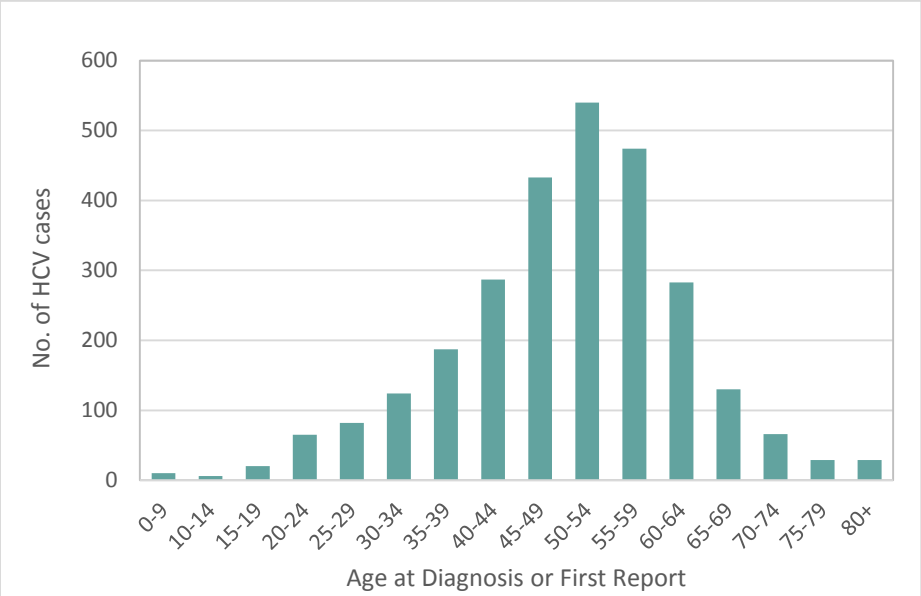


Figure 1. Incidence of chronic HCV in Yolo County, 2000-2015.

The mean age at diagnosis was 50 (standard deviation 12.5 years) with a median of 51 years (Figure 2).

Figure 2. Age at diagnosis or first report of chronic HCV infection, Yolo County Residents, 2000-2015.



There were more male than female cases (Table 3). This probably reflects a greater number of males who are IDUs, military veterans, and engage in risky behavior.

Table 3. Sex of HCV Cases.

Sex	No. of Cases	%
Female	1159	41.7%
Male	1616	58.2%
Unknown	5	0.2%

Table 4 depicts the race-ethnicity of chronic HCV cases. Nearly half of the cases were missing data on race-ethnicity (47%), since many of the lab reports prior to 2011 did not report race or ethnicity. In order for our conclusions to be valid, we assumed that the data were missing entirely at random. If this assumption is invalid, we may have over- or under-estimated the percentage of HCV cases represented by different race-ethnicities. Our comparison with the population showed that a lower percentage of American Indians, Asians and Hispanics and a higher percentage of persons of other or multiple race were infected with HCV than would be expected.

Table 4. Race-Ethnicity of chronic HCV Cases.

Race-Ethnicity	No. of Cases	% of Cases excluding Unknown*	% in Population (CA DOF)
Asian/Pacific Islander	43	2.8%	13.2%
American Indian	38	2.5%	0.5%
Black	78	5.1%	3.0%
Hispanic	301	19.6%	30.9%
NH†-Unk or NH/Unk-Other	331	21.6%	3.6%
NH/Unknown-White	741	48.4%	48.8%
Unknown	1247		

**Due to the high percentage of patients missing data, those with unknown race-ethnicity were excluded from the total when calculating this percentage.*
†Non-Hispanic

DATA QUALITY

The completeness of basic data elements was assessed and compared for three time periods in the latter part of the study period (Table 5). Date of birth was the most consistently reported data element and rarely missing from reports. The inclusion of a complete address has improved significantly with time, although nearly one-third of reports still lacked address in 2014-15. Recent updates by one of the larger labs that reports chronic HCV in the CalREDIE electronic reporting system will most likely lead to >95% of electronic lab reports (ELRs) containing the patient's address. There has been no improvement in reporting of race-ethnicity, despite the advent of ELR. Lack of race-ethnicity data limit our ability to evaluate racial and ethnic disparities among HCV patients (see above, Table 4).

Table 5. Comparison of Completeness of Basic Data Elements in 2010-11, 2012-13 and 2014-15.

	2010-11	2012-13	2014-15	Status
	% missing	% missing	% missing	
Race-ethnicity	61.1%	67.9%	64.3%	No improvement
Date of birth	0.9%	0.7%	0.2%	Meeting goal
Address	30.0%	33.5 %	22.1%	Improved
Total Reports	447	439	456	

CASE REPORTING AND CLASSIFICATION

Both clinical laboratories (since 2007) and medical providers are mandated by the Title 17 California Code of Regulations to report HCV within 7 days of diagnosis. Table 6 illustrates the frequency of lab reports (Lab Only), confidential morbidity reports (CMRs) from medical providers (CMR Only) and instances where both were received.

Table 6. Report sources for chronic HCV cases, 2000-2015.

Report Source	No. of Cases	%
CMR* and Lab	274	9.9%
CMR Only	33	1.2%
Lab Only	2472	89.0%
Total	**2779**	

**Confidential morbidity report*

Cases were classified as described in Table 7. The large number of "previously reported" designations relate to the high percentage of cases reported via ELRs in the CalREDIE system that had been previously reported in an earlier database.

Table 7. Classification of chronic HCV cases reported in Yolo County, 2000-2015.

Case Classification	No. of Cases	%
Confirmed	890	32.0%
Previously Reported	1616	58.2%
Probable	20	0.7%
Suspect	253	9.1%
Total	**2779**	

GEOGRAPHIC DISTRIBUTION OF CASES

Many records (30.3%) did not have addresses because in the early years of the time period, most lab reports lacked patient addresses. These cases could not be mapped to census tracts and were excluded from the prevalence map below (Figure 3). We again assumed that address data were missing at random, because the missing data spanned all records for a defined time period. This issue has been addressed in the current CalREDIE electronic reporting system and most ELRs are now submitted with patient address. A few cases were in homeless individuals (n=14, 0.5%).

Chronic HCV was more prevalent in northern parts of the city of West Sacramento, in two census tracts on the north and west sides of Woodland, and in northern rural areas of the county (Figure 3).

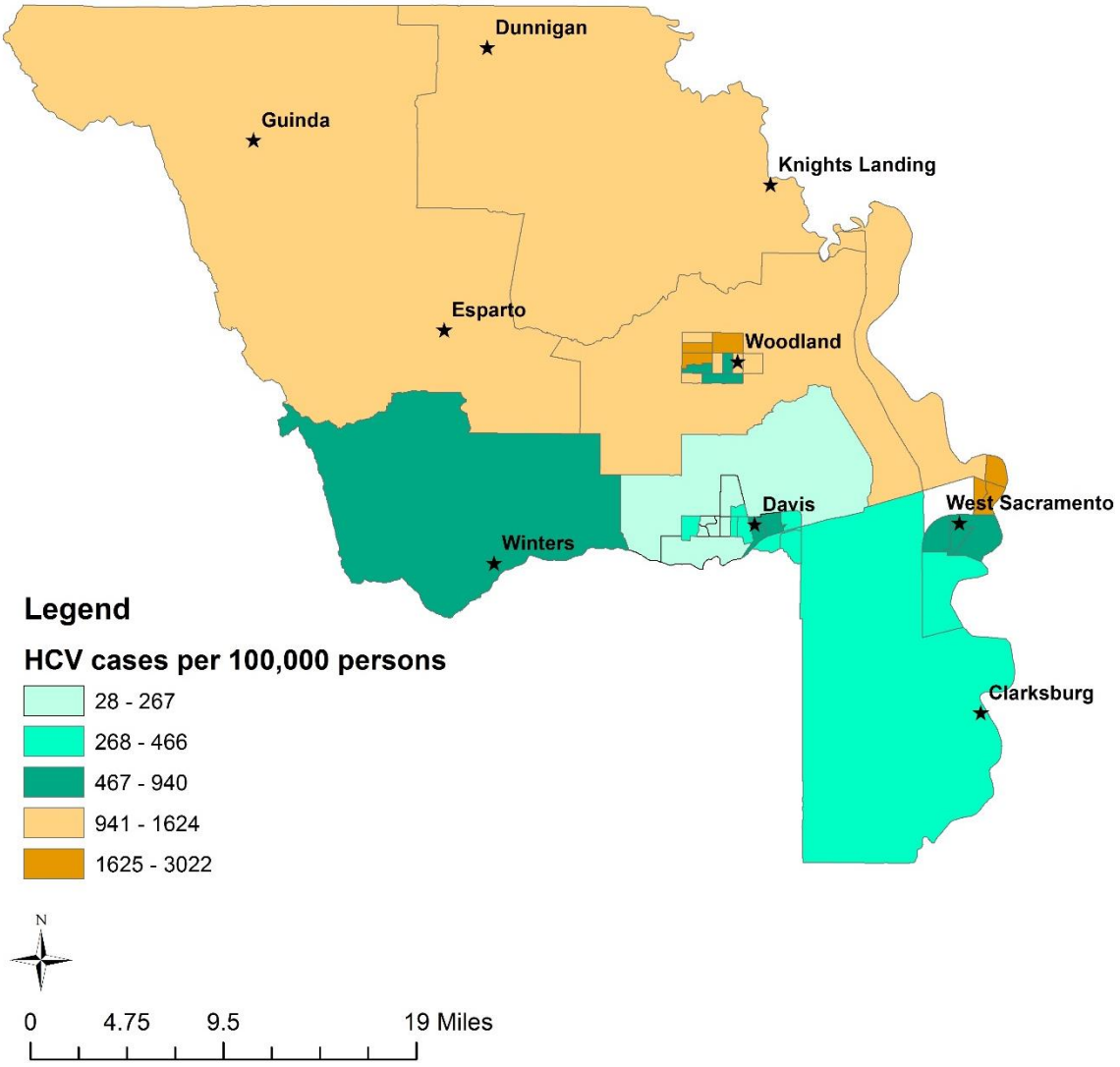


Figure 3. HCV prevalence per 100,000 persons (cases diagnosed from 2000 to 2015) by census tract, Yolo County.

An analysis of the correlation between the prevalence of chronic HCV infection and the proportion of the population over age 25 below 100% of the federal poverty level (FPL) by census tract was conducted. One census tract in Davis with a very low HCV prevalence and a high proportion of its adults aged 25+ living in poverty, primarily residents who were older (graduate) students, was dropped from the analysis on the basis of being an outlier. The correlation coefficient (ρ) for the remaining census tracts was 0.70, indicating that chronic HCV prevalence and the poverty rate were positively correlated. By interpretation, this means that the higher the prevalence of chronic HCV in a census tract, the higher the poverty rate in that census tract (Figure 4). The census tract with the highest prevalence (3,186 HCV

cases per 100,000 persons) was also the census tract with the highest percentage of adults aged 25+ in poverty (35.8%). The coefficient of determination (ρ^2, the fit of the data points to a line) for HCV cases and percent of the population 25+ in poverty was 0.49, indicating a relative poor fit to a line because of variation in the data.

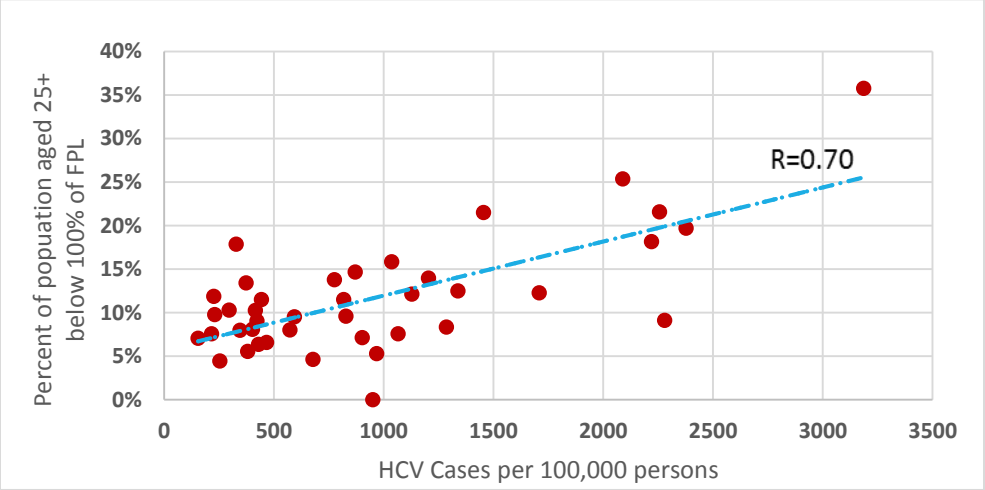
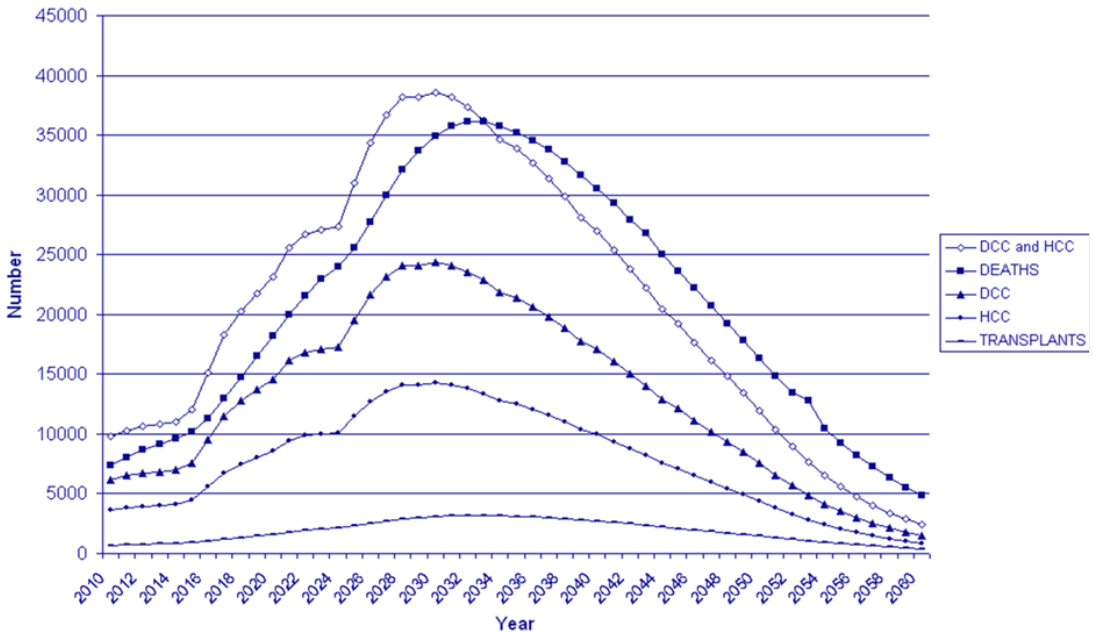


Figure 4. Correlation of HCV prevalence with the percentage of persons aged 25+ below 100% of the FPL (outlier census tract 105.01 removed), Yolo County 2000-2015.

MORTALITY

In the United States, deaths from chronic HCV are expected to rise rapidly until 2035, declining thereafter (Figure 5).



Key: DCC-decompensated cirrhosis, HCC-hepatocellular carcinoma.

Figure 5. Forecasted health outcomes for persons with chronic HCV and no liver cirrhosis, United States 2010 to 2060.[9]

Among the 2,779 Yolo County cases, 412 deaths occurred (14.8%). The mean age at death was 59 years (standard deviation 10.4 years) and median age 58 years (Figure 6). The average time from diagnosis to death was 7.6 years, excluding 94 of the 412 cases that were diagnosed right before or just after death. Deceased cases with no prior report most likely occurred because they were diagnosed prior to mandated reporting, were reported in other counties, or were not recognized until severe complications of chronic HCV infection had developed.

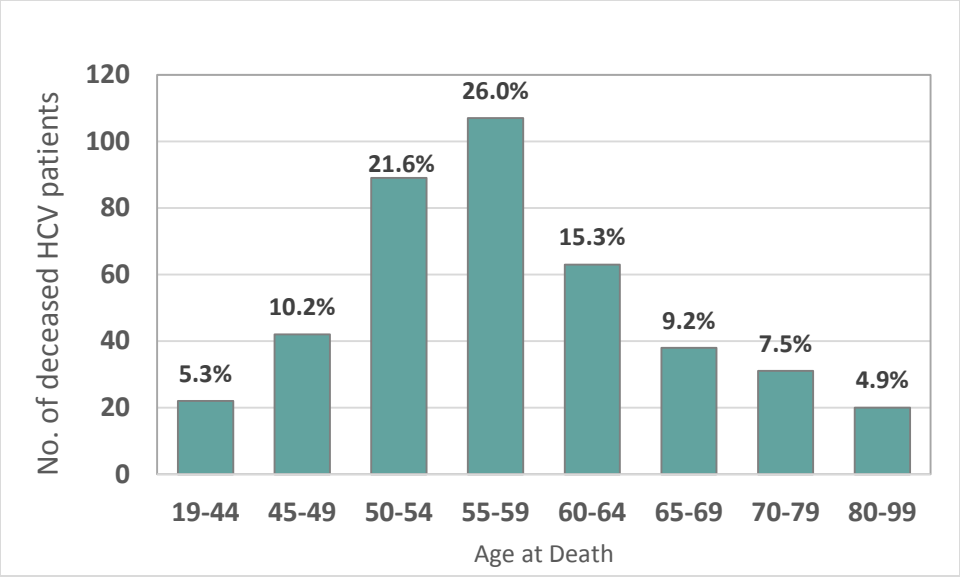


Figure 6. Age at death for HCV patients diagnosed in Yolo County (n=412) with percentage of deaths represented by each age group.

A premature death is defined as a death in a person aged under 75 years old. Clearly, chronic HCV was responsible for many premature deaths. More than 95% of the causes of death were related to HCV complications, usually hepatocellular carcincoma (liver cancer), liver cirrhosis or liver failure. Some deaths were due to alcoholic liver cirrhosis, alcohol or drug overdose, and suicide. Nearly one-half of deaths (48%) were in persons aged 50 to 59 years old, and one-quarter (26%) occured in the 55- to 59-year-old age group. Many of the death records indicated co-occurring chronic conditions such as alcoholism, drug abuse, diabetes and chronic disease of the circulatory system (heart and blood vessels).

LAWS AND RECOMMENDATIONS FOR REPORTING

HCV is currently mandated as a reportable communicable disease under California Code of Regulations Title 17 §2500, §2593, §2641.5-2643.20, and §2800-2812, reportable within 7 days of recognition (i.e., a positive lab result). In June 2013, the U.S. Preventive Services Task Force recommended that all high-risk individuals (see Introduction) and anyone born between 1945 and 1965 be screened for HCV.[10]

SUMMARY AND CONCLUSIONS

Currently, 200 to 250 persons are newly recognized each year as having chronic HCV infection in Yolo County. Our data suggest about 2,800 Yolo County residents are infected with HCV. These patients need access to effective care and treatment.

Newly diagnosed patients should receive prompt referral to specialists and ongoing testing to monitor viral loads and the progress of their disease. Improving the quality of care and treatment for persons infected with chronic HCV will reduce the long-term costs of their medical care, reduce mortality and morbidity, and improve health outcomes.

The communicable diseases electronic lab reporting (ELR) system implemented in most local health departments statewide from 2010 to 2011 (CalREDIE) has greatly improved the timeliness and completeness of HCV reporting. However, nearly half of the HCV cases reported to Yolo County lacked race-ethnicity and 30% lacked address data. The implementation of ELR in 2012 and 2013, which is ongoing, should reduce missing information and improve data quality. The CalREDIE system and linkage to electronic death records enabled Yolo County to conduct surveillance about chronic HCV and track deaths among HCV patients. Knowledge about patient demographics and disease trends enables us to determine where to direct public education and outreach, and to monitor the success of these endeavors.

HCV has been dubbed “the silent killer” because so many patients are unaware of their infection status. One hundred and twenty-nine cases (4.6%) in our series were diagnosed after or within six months of the date of death. Research by the National Institutes of Health suggests that as many as 65% to 70% of chronic HCV patients are unaware of their infection status.[3] Healthcare providers can recommend that their patients get tested for HCV, which is relatively inexpensive and covered by health insurance plans. They should encourage high-risk patients (military veterans, IDUs of any age, recipients of blood transfusions or organ transplants prior to 1992, HIV-infected patients, babies born to HCV-infected mothers, homeless persons, and anyone born between 1945 and 1965) to be tested for HCV.

The California Department of Public Health 2014-16 Action Plan[12] continues to advocate for patients to learn about their HCV status and discuss HCV testing with their medical provider if they have never been tested before.

REFERENCES

1. Centers for Disease Control and Prevention (CDC), Atlanta, GA. http://www.cdc.gov/hepatitis/HCV/index.htm, accessed 9/18/2015.
2. Centers for Disease Control and Prevention, Atlanta, GA. Hepatitis C: Testing baby boomers saves lives, accessed 9/18/2015.
3. National Institutes of Health Consensus Development Panel Conference statement: management of hepatitis C. 2007. Hepatology 26(Suppl 1):2S-10S.
4. Pyenson, B., et al. Consequences of hepatitis C virus (HCV): Costs of a baby boomer epidemic of liver disease. New York: Milliman; May 2009.
5. California Department of Public Health Immunization Branch. Hospitalization costs associated with liver disease, liver cancer and liver transplants for patients infected with hepatitis B or hepatitis C, California 2007.
6. Davis, K.L., et al. Direct economic burden of chronic hepatitis C virus in a United States managed care population. 2011. Journal of Clinical Gastroenterology 45(2):e17-e24.
7. Davila, J.A., et al. Hepatitis C infection and the increasing incidence of hepatocellular carcinoma: a population-based study. 2004. Gastroenterology 127(5):1372-1380.
8. Davis, G.L., et al. Projecting future complications of chronic hepatitis C in the United States. 2003. Liver Transplantation 9(4):331-338.
9. Ly, K., et al. The increasing burden of mortality from viral hepatitis in the United States between 1999 and 2007. 2012. Annals of Internal Medicine 156(4):271-278.
10. U.S. Preventive Services Task Force. 2013. Screening for hepatitis C virus infection in adults. http://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/hepatitis-c-screening, accessed 9/18/2015.
11. University of Wisconsin. HCV Epidemiology in the United States. http://www.hepatitisc.uw.edu/pdf/screening-diagnosis/epidemiology-us/core-concept/all, accessed 9/18/2015.
12. Action Plan for the Prevention, Care, and Treatment of Viral Hepatitis 2014-2016. California Department of Public Health, Office of Viral Hepatitis Prevention, Richmond, CA. http://www.cdph.ca.gov/programs/Documents/Viral-Hepatitis-Action-Plan.pdf, accessed 9/22/2015.