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Measuring chronic liver disease mortality using an expanded cause of death definition and medical records in Connecticut, 2004

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Abstract

Aim: Chronic liver disease (CLD) is a leading cause of death and is defined based on a specific set of underlying cause-of-death codes on death certificates. This conventional approach to measuring CLD mortality underestimates the true mortality burden because it does not consider certain CLD conditions like viral hepatitis and hepatocellular carcinoma. We measured how much the conventional CLD mortality case definition will underestimate CLD mortality and described the distribution of CLD etiologies in Connecticut.

Methods: We used 2004 Connecticut death certificates to estimate CLD mortality two ways. One way used the conventional definition and the other used an expanded definition that included more conditions suggestive of CLD. We compared the number of deaths identified using this expanded definition with the number identified using the conventional definition. Medical records were reviewed to confirm CLD deaths.

Results: Connecticut had 29 314 registered deaths in 2004. Of these, 282 (1.0%) were CLD deaths identified by the conventional CLD definition while 616 (2.1%) were CLD deaths defined by the expanded definition. Medical record review confirmed that most deaths identified by the expanded definition were CLD-related (550/616); this suggested a 15.8 deaths/100 000 population mortality rate. Among deaths for which hepatitis B, hepatitis C and alcoholic liver disease were identified during medical record review, only 8.6%, 45.4% and 36.5%, respectively, had that specific cause-of-death code cited on the death certificate.

Conclusion: An expanded CLD mortality case definition that incorporates multiple causes of death and additional CLD-related conditions will better estimate CLD mortality.

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Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

Keywords

alcoholic liver disease; chronic liver disease mortality definition; hepatitis B; hepatitis C

INTRODUCTION

IN 2011, CHRONIC liver disease (CLD) was the 12th leading cause of death in the USA, accounting for 10.8 deaths/100 000 population.[1] However, CLD mortality is underestimated due to how CLD has been traditionally defined.[2–5] The "conventional" CLD mortality definition considers only alcoholic liver disease (ALD), liver fibrosis and liver cirrhosis underlying cause of death codes listed on death certificates. Hepatitis B and hepatitis C are known CLD etiologies,[6] but they are not included in this conventional definition neither are hepatocellular carcinoma (HCC) and other conditions highly suggestive of CLD. Additionally, this conventional method considers only underlying death causes and not associated death causes.

Over the past decade, the use of comprehensive condition codes to measure the CLD burden and mortality has become more widely accepted.[2,5–8] However, data published in widely cited reports, for example, by the National Center for Health Statistics, continue to apply the conventional CLD mortality definition. A 2004 mortality study found that the magnitude by which US CLD mortality is underestimated using the conventional definition is significant.[2] This study used medical records to investigate the CLD mortality rate among deceased members of a large managed care health plan in the year 2000.[2] The authors concluded that CLD mortality nearly doubled when a list of mortality codes was used that included viral hepatitis, HCC and other known CLD etiologies and outcomes.[2] CLD mortality estimates are also underestimated because causes of death listed on death certificates may be incomplete or misclassified. The same study found that the proportion of CLD deaths attributable to viral hepatitis and ALD approximately doubled with medical record review because death records often did not reflect CLD etiologies that were documented in the medical records.[2] These findings may not represent the USA; the study population was insured and did not include lower income populations who have higher CLD risk.[9]

Our objectives were to use 2004 Connecticut death certificate data to validate an expanded definition of CLD mortality and characterize these deaths. Specifically, we: (i) measured CLD mortality using the conventional case definition and compared it with an expanded case definition to assess underestimation; (ii) described the distribution and demographic characteristics of CLD and its etiologies among medical record-confirmed CLD deaths; and (iii) examined the extent to which hepatitis B, hepatitis C and ALD are excluded on death certificates.

METHODS

CLD mortality definitions

We reviewed all 2004 death certificates listed in the Connecticut Department of Public Health mortality database of electronic death certificates. We used the International

Classification of Diseases, Tenth Revision (ICD-10)[10] codes listed on the death certificates to identify potential CLD deaths. We defined CLD mortality with both conventional and expanded definitions.

A conventional CLD death was defined using the National Center for Health Statistics' current CLD mortality definition.[11] These were deaths where the underlying cause of death was coded as: ALD; chronic hepatitis, not elsewhere classified; or fibrosis and cirrhosis of liver (ICD-10 codes: K70, K73, K74) (asterisk ICD-10 codes in Appendix I).

Chronic liver disease deaths met the expanded case definition if we saw at least one of the following criteria on the death certificate: (i) an ICD-10 code that was highly suggestive of CLD as the underlying cause of death (Appendix I); (ii) an ICD-10 code that was suggestive of CLD as the underlying cause of death (Appendix II) and a highly suggestive CLD ICD-10 code listed as a multiple cause of death (Appendix I); or (iii) an HIV ICD-10 code (ICD-10 codes B20-B24) as the underlying cause of death, and a highly suggestive CLD ICD-10 code as a multiple cause of death (Appendix I). The decision to add the third criterion was based on an ICD-10 coding rule[12] that excluded infectious conditions like viral hepatitis from multiple causes of death if HIV also appeared as a cause of death. All CLD deaths that met the conventional definition also met the expanded definition.

To meet the confirmed case definition, a potential CLD death identified using the expanded case definition had to be verified by medical record review to have evidence of death due to CLD. Medical record reviewers looked for the presence of certain conditions such as liver cirrhosis, alcoholic liver disease and HCC. In addition, the reviewers noted when CLD signs and symptoms, imaging studies indicating CLD or liver biopsies indicating CLD were present in the medical records as supporting evidence of death due to CLD.

Medical record review methodology

During January 2007–June 2008, the medical records of decedents who had a potential CLD death in 2004 were reviewed and CLD-related information was abstracted to confirm evidence of a CLD death. The reviewers contacted the hospital, long-term care facility or hospice listed on the death certificate and requested the decedent's medical records. This information was usually identified from the place of death listed on the death certificate. For deaths that occurred outside a facility, the death certifier or medical examiner was contacted for medical records.

Key information abstracted from medical records included CLD etiologies and types, alcohol exposure and viral hepatitis status. If key information was found in the first medical record source, then the review was considered complete and no additional sources were sought. If the first source was inadequate to obtain key information, a second source was sought and reviewed. If reviewers found multiple sources, they selected the highest quality source. Sections of the data abstraction form that were not considered key sections, yet were abstracted if available, included CLD signs and symptoms, liver transplantation, liver and/or spleen imaging studies, liver biopsy or autopsy findings and HIV infection documentation.

Demographic and clinical information for each CLD decedent was taken from the death certificate and included cause of death, sex, race/ethnicity, age and place of birth. If we noted a discrepancy in demographic factors between death certificate and medical record information, medical record information was considered more accurate. When forms were complete, personal identifying information was removed and the forms were sent to the Centers for Disease Control and Prevention, Division of Viral Hepatitis, for data entry into an electronic database.

Determining CLD etiologies

Hepatitis C was evidenced as having a: hepatitis C ICD-10 code (B17.1, B18.2) listed anywhere on the death certificate; positive hepatitis C antibody test; positive hepatitis C RNA qualitative or quantitative test; hepatitis C genotype; or mention of hepatitis C infection in the medical records. Hepatitis B was evidenced as having a: hepatitis B ICD-10 code (B16, B17.0, B18.0, B18.1) listed anywhere on the death certificate; positive hepatitis B surface antigen test; positive hepatitis B DNA test; positive hepatitis B e-antigen test; or mention of hepatitis B infection in the medical records. ALD was evidenced as having an: autopsy report indicating ALD; ALD ICD-10 code (K70) listed anywhere on the death certificate; or ALD/Laennec's cirrhosis mention in the medical records including a liver biopsy report. Non-alcoholic steatohepatitis/non-alcoholic fatty liver disease (NASH/NAFLD) was evidenced in the absence of ALD as having a/an: autopsy report indicating NASH, NAFLD, fatty liver, liver steatosis or steatohepatitis; NASH or NAFLD ICD-10 code (K75.8, K76.0) listed anywhere on the death certificate; NASH or NAFLD mention in the medical records including a diagnosis of fatty liver by an imaging study; or diagnosis of NASH, NAFLD, fatty liver, liver steatosis or steatohepatitis by a liver biopsy report.

Determining HCC and cirrhosis

Chronic liver disease deaths with an indication of HCC had a/an: HCC ICD-10 code (C22.0) listed anywhere on the death certificate; or physician's note, liver biopsy or autopsy report indicating HCC. CLD deaths with an indication of cirrhosis had a: cirrhosis ICD-10 code (K70.3, K71.7, K74.3, K74.4, K74.5, and K74.6) listed anywhere on the death certificate; or physician's note, liver biopsy or autopsy report indicating cirrhosis regardless of presumed etiology.

Statistical analysis

We calculated crude mortality rates for each CLD definition (conventional and expanded) and also for the confirmed CLD deaths. We compared mortality rates using the Pearson χ^2-test and considered $P < 0.05$ significant. We examined mortality rates by demographic categories. To calculate these rates, we divided the number of CLD deaths for each demographic category by the 2004 US Census–Connecticut population estimates. The denominator for calculating mortality rates by place of birth was obtained from the 2004 American Community Survey–Connecticut population estimates.[13]

We examined the distribution of select CLD etiologies occurring alone and in combination with each other. These included hepatitis B, hepatitis C, ALD and NASH/NAFLD, and were selected based on recent CLD studies.[2,6] Among confirmed CLD deaths with ALD and

hepatitis C – the major CLD etiologies identified from those studies[2,6] – we described the distribution of cirrhosis and HCC and demographics. Deaths that had a CLD etiology other than hepatitis B, hepatitis C, ALD and NASH/NAFLD were termed “other”.

Among confirmed CLD deaths, we compared how many had a mention of hepatitis B, hepatitis C or ALD documented in the medical records but not reported on the death certificate. Data were analyzed using SAS software version 9.2 (SAS Institute, Cary, NC, USA).

RESULTS

Comparison of CLD mortality definitions

In 2004, the Connecticut population was 3.475 million persons and 29 314 deaths were registered. We identified 616 (2.1%) deaths that met the expanded CLD definition compared with 282 (1.0%) using the conventional definition (Table 1). Of these, 568 deaths had an ICD-10 code that was highly suggestive of CLD as the underlying cause of death (Appendix I); 50 of these deaths plus one additional death had an ICD-10 code that was suggestive of CLD as the underlying cause of death (Appendix II) and a highly suggestive CLD ICD-10 code listed as a multiple cause of death (Appendix I). An additional 47 deaths had a HIV ICD-10 code (ICD-10 codes B20-B24) as the underlying cause of death, and a highly suggestive CLD ICD-10 code as a multiple cause of death (Appendix I).

Medical record review confirmed that CLD was a cause of 550 (89.3%) of the 616 deaths identified by the expanded case definition (mortality rate = 15.8 deaths/100 000 population) (Table 1). Of confirmed CLD deaths, 91.8% had at least one CLD sign or symptom, 82.2% had at least one imaging study indicating CLD and 22.2% had a liver biopsy indicating CLD. Of the 66CLD deaths that were not confirmed by medical record review, 31 did not have CLD; 11 could be neither confirmed nor ruled out; and medical records were not available for 24. Of the 31 decedents who did not have CLD, 10 had a metastatic cancer to the liver, three had a cause of death coding error that was actually chronic lung disease, and for 18, the medical records indicated that the death was not due to CLD. The demographic profiles of the conventional, expanded and confirmed CLD definitions were similar.

Characteristics of confirmed CLD deaths

Confirmed CLD deaths were mostly male, non-Hispanic white, born before 1945, and born in the USA (Table 1). Median age at death was 60 years (range, 22–99 years). Confirmed CLD mortality rates increased significantly with increasing age from 3.8 deaths/100 000 population among decedents aged 22–44 years to 48.6 deaths/100 000 population among decedents aged 65 years or more ($P < 0.001$). Although the proportion of decedents with confirmed CLD was much higher in US-born (82.8%) than non-US-born decedents (18.7%), mortality rates were slightly higher in non-US-born (18.7 deaths/100 000 population) than US-born decedents (15.7 deaths/100 000 population).

Chronic liver disease etiologies among confirmed CLD deaths included 51.1% with ALD, 35.3% with hepatitis C, 17.1% with other CLD etiologies, 6.7% with hepatitis B and 8.2% with NASH/NAFLD (Table 2). Deaths with either ALD or NASH/NAFLD more

frequently occurred with hepatitis C than with hepatitis B. There were 44 deaths with etiologies different from hepatitis B, hepatitis C, ALD or NASH/NAFLD. Of these deaths, the CLD etiologies/types listed were cryptogenic liver disease (n = 30), hemochromatosis (n = 2), primary biliary cirrhosis (n = 2), primary sclerosing cholangitis (n = 3), autoimmune hepatitis (n = 2), α1-antitrypsin deficiency (n = 1), cholangiocarcinoma (n = 1), chronic cholestatic liver disease (n = 1), vascular liver disease (n = 1) and possible ALD based on a liver biopsy report indicating micronodular cirrhosis (n = 1). A CLD etiology was not identified in 81 deaths; however, of these deaths, 87.7% had at least one CLD sign or symptom, 82.7% had at least one imaging study indicating CLD and 29.6% had a liver biopsy indicating CLD.

The distribution of HCC and cirrhosis among confirmed CLD deaths included 63.1% with evidence of cirrhosis alone, 9.3% with evidence of HCC alone, 13.8% with evidence of both HCC and cirrhosis, and 13.8% with no evidence of either condition. Amongdeaths with hepatitis C, 76.3% had cirrhosis and 23.7% had HCC (Table 3). Overall, cirrhosis was present in the majority of CLD deaths associated with hepatitis C and/or ALD (range, 76.2–83.0%); HCC contributed to a smaller fraction of disease (range, 8.6–23.7%). We found neither cirrhosis nor HCC noted in the records of nearly one-fifth of CLD decedents with hepatitis C. The demographic characteristics of CLD deaths associated with hepatitis C and ALD were similar. These decedents were mostly male, NH white, born during 1945–1965, and born in the USA.

Despite having a confirmed CLD death, only 8.6% of patients with hepatitis B listed in their medical records, 45.4% of patients with hepatitis C listed in their medical records and 36.5% of patients with ALD listed in their medical records had the condition cited on the death certificate.

DISCUSSION

We found that an expanded CLD mortality definition that took into account common CLD etiologies and types like viral hepatitis and HCC captured more than double the CLD deaths identified from the conventional CLD definition. These additional CLD conditions contribute a significant fraction of CLD disease.[2,6] Our results confirm observations from two other validation studies, which found that approximately 50% of CLD deaths would not have been identified with only the conventional definition.[2,5]

In our study, the most common CLD etiologies among CLD deaths were ALD and hepatitis C; occurring together, they disproportionately affected decedents born during 1945–1965. Nationally, this birth cohort carries the highest burden of hepatitis C virus infection[14] and one-time screening of this cohort is cost-effective[15] and recommended[16] by the Centers for Disease Control and Prevention. Our findings strengthen this recommendation. Also critical is the need to increase the number of patients counseled about abstaining from alcohol consumption because alcohol use not only worsens clinical outcomes but is contraindicated for hepatitis C therapy.[16] Other measures that can prevent complications of hepatitis C infection are hepatitis A and B vaccination[17] and referral to specialty care.[16]

We found that nearly one-fourth of hepatitis C-related deaths had HCC, the majority of which also had cirrhosis. These findings may be explained by the fact that chronic hepatitis C infection is associated with HCC risk; and in most cases, cirrhosis not only precedes HCC but can act synergistically to worsen HCC by hepatocyte regeneration.[18,19] CLD decedents who had hepatitis C and ALD also had a higher prevalence of cirrhosis than CLD decedents with hepatitis C, presumably because ALD acts synergistically with hepatitis C to progress liver disease.[20]

Our results demonstrate the substantial under-reporting of hepatitis B, hepatitis C and ALD on death certificates.[2] The majority of these CLD death etiologies were not recorded on the death certificate. Until these etiologies are counted as CLD contributors on death certificates, measuring the true contribution of hepatitis B, hepatitis C and ALD to CLD mortality will require supplementing death certificate data with more comprehensive data sources, such as patient medical records.

Our study has limitations. First, we could not find medical records for 24 deaths and, therefore, could neither confirm nor rule out CLD as a cause of death for these and another 11 deaths with available medical records but insufficient information. However, we were able to confirm nearly 90% of CLD deaths using medical records. Second, our sample size limited our ability to evaluate whether any specific ICD-10 code is truly a good indication of CLD death. For example, 12 of the codes in Appendix I and 45 of the codes in Appendix II were not present in any of the death certificates of potential CLD deaths. Third, the data used in our study were 10 years old and may create concerns about the relevance of the study's findings to current health issues. Therefore, examination of the CLD mortality rate in 2011, the most recent available year of mortality data, was done to determine whether any drastic changes have occurred in the CLD mortality burden since this study was conducted. The National Center for Health Statistics mortality report found that, in 2011, the Connecticut CLD mortality rate, which applied the conventional case definition, was 8.7 deaths/100 000 population,[1] representing a 6.2% rate increase since 2004. Even with this slight increase, however, we believe that the use of more recent data would not have changed the main finding of this study which is that the conventional CLD mortality case definition significantly underestimates the true CLD mortality burden.

Incorporating conditions that are highly suggestive of CLD into the conventional CLD mortality case definition will provide a more realistic estimate of the CLD mortality burden. An expanded list of CLD condition codes has been applied in recent studies;[5,8] however, mortality reports published by the National Center for Health Statistics use the restricted definition. In order to measure the true CLD mortality burden, the use of an expanded definition should become the standard for measuring CLD mortality. We found that hepatitis B, hepatitis C and ALD were heavily underreported in death certificate data which reinforces the limitations of death certificate data. We also found that ALD and hepatitis C were the main CLD etiologies in these CLD deaths. Preventative measures can reduce their occurrence and achieve declines in CLD morbidity and mortality.

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APPENDIX I: ICD-10 CODES THAT ARE HIGHLY SUGGESTIVE OF CHRONIC LIVER DISEASE

Cause of death	ICD-10 code
Viral hepatitis	
Acute hepatitis B	B16
Other acute viral hepatitis	B17
Chronic viral hepatitis	B18
Unspecified viral hepatitis	B19
Sequelae of other and unspecified infectious and parasitic diseases	
Sequelae of viral hepatitis	B94.2
Malignant neoplasm of the liver and intrahepatic bile ducts	
Liver cell carcinoma	C22.0
Malignant neoplasm of the liver, unspecified	C22.9
Esophageal varices	
Esophageal varices with bleeding	I85.0
Esophageal varices without bleeding	I85.9
Alcoholic liver disease †	
Alcoholic fatty liver	K70.0
Alcoholic hepatitis	K70.1
Alcoholic fibrosis and sclerosis of liver	K70.2 *
Alcoholic cirrhosis of liver	K70.3
Alcoholic hepatic failure	K70.4
Alcoholic liver disease, unspecified	K70.9
Hepatic failure, NEC	
Chronic hepatic failure	K72.1
Hepatic failure, unspecified	K72.9
Chronic hepatitis, NEC †	
Chronic persistent hepatitis, NEC	K73.0 *
Chronic lobular hepatitis, NEC	K73.1 *
Chronic active hepatitis, NEC	K73.2 *
Other chronic hepatitis, NEC	K73.8 *
Chronic hepatitis, unspecified	K73.9
Fibrosis and cirrhosis of the liver †	
Hepatic fibrosis	K74.0 *

Cause of death	ICD-10 code
Hepatic sclerosis	K74.1 *
Hepatic fibrosis with hepatic sclerosis	K74.2 *
Primary biliary cirrhosis	K74.3 *
Secondary biliary cirrhosis	K74.4 *
Biliary cirrhosis, unspecified	K74.5 *
Other and unspecified cirrhosis of the liver	K74.6
Other diseases of the liver	
Fatty (change of) liver, NEC‡	K76.0
Hepatic veno-occlusive disease	K76.5 *
Portal hypertension	K76.6
Hepatorenal syndrome	K76.7
Liver disease, unspecified	K76.9
Failure and rejection of transplanted organs and tissues	
Liver transplant failure and rejection	T86.4

* These codes were included in our search but were not found on any records.

† These codes were used in the National Center for Health Statistics conventional definition of CLD.

‡ Non-alcoholic fatty liver disease.

NEC, not elsewhere classified.

APPENDIX II: ICD-10 CODES THAT ARE SUGGESTIVE OF CHRONIC LIVER DISEASE

Cause of death	ICD-10 code
Carcinoma *in situ* of other and unspecified digestive organs	
Liver, gallbladder, bile ducts and ampulla of Vater	D01.5 *
Benign neoplasm of other and ill-defined parts of digestive system	
Liver and intrahepatic bile ducts	D13.4 *
Neoplasm of uncertain or unknown behavior of oral cavity and digestive organs	
Liver, gallbladder, bile ducts and ampulla of Vater	D37.6
Disorders of porphyrin and bilirubin metabolism	
Hereditary erythropoietic porphyria	E80.0 *
Porphyria cutanea tarda	E80.1 *
Other porphyria	E80.2 *
Defects of catalase and peroxidase	E80.3 *
Gilbert's syndrome	E80.4 *
Crigler–Najjar syndrome	E80.5 *
Other disorders of bilirubin metabolism	E80.6 *
Disorder of bilirubin metabolism, unspecified	E80.7 *
Disorders of mineral metabolism	
Disorders of copper metabolism	E83.0 *
Disorders of iron metabolism	E83.1 *

Cause of death	ICD-10 code
Disorders of phosphorus metabolism and phosphatases	E83.3 *
Disorders of magnesium metabolism	E83.4
Disorders of calcium metabolism	E83.5 *
Other disorders of mineral metabolism	E83.8 *
Other metabolic disorders	
Disorders of plasma-protein metabolism, NEC	E88.0
Portal vein thrombosis	
Portal vein thrombosis	I81
Other venous embolism and thrombosis	
Budd-Chiari syndrome	I82.0 *
Toxic liver disease	
Toxic liver disease with cholestasis	K71.0 *
Toxic liver disease with hepatic necrosis	K71.1 *
Toxic liver disease with acute hepatitis	K71.2 *
Toxic liver disease with chronic persistent hepatitis	K71.3 *
Toxic liver disease with chronic lobular hepatitis	K71.4 *
Toxic liver disease with chronic active hepatitis	K71.5 *
Toxic liver disease with hepatitis, NEC	K71.6 *
Toxic liver disease with fibrosis and cirrhosis of liver	K71.7 *
Toxic liver disease with other disorders of liver	K71.8 *
Toxic liver disease, unspecified	K71.9 *
Hepatic failure, NEC	
Acute and subacute hepatic failure	K72.0
Other inflammatory liver diseases	
Phlebitis of portal vein	K75.1 *
Nonspecific reactive hepatitis	K75.2 *
Granulomatous hepatitis, NEC	K75.3 *
Autoimmune hepatitis	K75.4
Other specified inflammatory liver diseases †	K75.8 *
Inflammatory liver disease, unspecified	K75.9 *
Other diseases of the liver	
Chronic passive congestion of the liver	K76.1 *
Central hemorrhagic necrosis of the liver	K76.2 *
Infarction of the liver	K76.3 *
Peliosis hepatis	K76.4 *
Other specified diseases of the liver	K76.8
Other diseases of the biliary tract	
Cholangitis	K83.0
Obstruction of bile duct	K83.1 *
Perforation of bile duct	K83.2 *
Fistula of bile duct	K83.3 *
Spasm of sphincter of Oddi	K83.4 *

Cause of death	ICD-10 code
Biliary cyst	K83.5*
Other specified disease of biliary tract	K83.8*
Disease of biliary tract, unspecified	K83.9*
Hepatomegaly, NEC	
Hepatomegaly, NEC	R16.0*
Hepatomegaly with splenomegaly, NEC	R16.2*
Unspecified jaundice	
Unspecified jaundice	R17*
Ascites	
Ascites	R18

*These codes were included in our search but were not found on any records.

†Non-alcoholic steatohepatitis. NEC, not elsewhere classified.

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Table 1

CLD)mortality rates by CLD case definition and demographic factor–Connecticut, 2004

Category	Conventional case definition			Expanded case definition			Expanded and confirmed by medical record review		
	n (%)	Rate†	*P* ‡	*n* (%)	Rate†	*P* ‡	*n* (%)	Rate†	*P* ‡
Total	282	8.1		616	17.7		550	15.8	
Sex									
Female	100 (35.5)	5.6	Ref.	208 (33.8)	11.7	Ref.	186 (33.8)	10.4	Ref.
Male	182 (64.5)	10.8	<0.001	408 (66.2)	24.1	<0.001	364 (66.2)	21.5	<0.001
Age, years									
<45	37 (13.1)	1.8	<0.001	87 (14.2)	4.1	<0.001	80 (14.6)	3.8	<0.001
45–64	133 (47.2)	15.0	0.0002	266 (43.3)	30.0	<0.001	242 (44.0)	27.2	<0.001
≥65	112 (39.7)	23.9	Ref.	261 (42.5)	55.6	Ref.	228 (41.5)	48.6	Ref.
Year of birth									
Born before 1945	147 (52.1)	23.5	Ref.	325 (52.9)	51.9	Ref.	289 (52.6)	46.1	Ref.
Born during 1945–1965	127 (45.0)	11.7	<0.001	265 (43.2)	24.4	<0.001	238 (43.3)	22.0	<0.001
Born after 1965	8 (2.8)	0.5	<0.001	24 (3.9)	1.4	<0.001	23 (4.2)	1.3	<0.001
Race/ethnicity									
White, NH	228 (80.9)	8.6	Ref.	474 (77.0)	18.0	Ref.	427 (77.6)	16.2	Ref.
Black, NH	22 (7.8)	7.0	0.33	67 (10.9)	21.2	0.21	56 (10.2)	17.7	0.53
Hispanic	29 (10.3)	7.9	0.63	68 (11.0)	18.4	0.85	61 (11.1)	16.5	0.88
Asian/Pacific Islander, NH	3 (1.1)	2.9	0.04	7 (1.1)	6.7	0.01	6 (1.1)	5.7	0.01
Place of birth									
Non-US	43 (15.3)	8.6	0.81	106 (17.3)	21.1	0.09	94 (17.2)	18.7	0.12
US	238 (84.7)	8.2	Ref.	508 (82.7)	17.6	Ref.	454 (82.9)	15.7	Ref.

† Per 100 000 population.

‡ Pearson χ2-test for differences in mortality rates.

Missing values were not included in calculations.

CLD, chronic liver disease; NH, non-Hispanic.

Table 2

CLD etiologies among confirmed CLD deaths–Connecticut, 2004 (n = 550)

CLD etiology	*n* (%)
Hepatitis B alone	6 (11)
Hepatitis C alone	79 (14.4)
ALD alone	161 (29.3)
NASH/NAFLD alone	18 (3.3)
Other alone	44 (8.0)
Hepatitis B and C	7 (13)
Hepatitis B and ALD	9 (16)
Hepatitis B and NASH/NAFLD	0 (0.0)
Hepatitis C and ALD	74 (13.4)
Hepatitis C and NASH/NAFLD	10 (1.8)
Hepatitis B, hepatitis C and ALD	8 (14)
Hepatitis B, hepatitis C and NASH/NAFLD	3 (0.5)
Hepatitis B and other	2 (0.4)
Hepatitis C and other	5 (0.9)
ALD and other	23 (4.2)
NASH/NAFLD and other	11 (2.0)
Hepatitis B, hepatitis C, ALD and other	1 (0.2)
Hepatitis B, hepatitis C, NASH/NAFLD and other	0 (0.0)
Hepatitis B, hepatitis C and other	0 (0.0)
Hepatitis B, ALD and other	1 (0.2)
Hepatitis B, NASH/NAFLD and other	0 (0.0)
Hepatitis C, ALD and other	4 (0.7)
Hepatitis C, NASH/NAFLD and other	3 (0.6)
No etiologies identified	81 (14.7)

The category “other” did not include the following CLD etiologies: hepatitis B, hepatitis C, ALD or NASH/NAFLD. ALD, alcoholic liver disease; CLD, chronic liver disease; NASH/NAFLD, non-alcoholic steatohepatitis/non-alcoholic fatty liver disease.

Table 3

Characteristics of confirmed CLD deaths with hepatitis C and ALD by HCC, cirrhosis and demographic factors–Connecticut, 2004

Category	Hepatitis C and ALD† (*n* = 87) *n* (%)	Hepatitis C‡ (*n* = 194) *n* (%)	ALD‡ (*n* = 281) *n* (%)
Cirrhosis and HCC categories			
Only cirrhosis noted§	64 (73.6)	113 (58.3)	214 (76.2)
Only HCC noted¶	4 (4.6)	11 (5.7)	5 (1.8)
Cirrhosis and HCC noted	7 (8.0)	35 (18.0)	19 (6.8)
Neither cirrhosis nor HCC noted	12 (13.8)	35 (18.0)	43 (15.3)
Sex			
Female	22 (25.3)	64 (33.0)	73 (26.0)
Male	65 (74.7)	130 (67.0)	208 (74.0)
Age, years			
<45	15 (17.2)	37 (19.1)	46 (16.4)
45–64	64 (73.6)	120 (61.9)	156 (55.5)
≥65	8 (9.2)	37 (19.1)	79 (28.1)
Median age (range)	52 (33–85)	53 (32–90)	56 (27–91)
Year of birth			
Born before 1945	15 (17.2)	55 (28.4)	116 (41.3)
Born during 1945–1965	68 (78.2)	131 (67.5)	151 (53.7)
Born after 1965	4 (4.6)	8 (4.1)	14 (5.0)
Race/ethnicity			
White, NH	50 (57.5)	115 (59.3)	224 (79.7)
Black, NH	16 (18.4)	38 (19.6)	25 (8.9)
Hispanic	20 (23.0)	40 (20.6)	30 (10.7)
Asian/Pacific Islander, NH	1 (1.1)	1 (0.5)	2 (0.7)
Place of birth			
Non-US	17 (20.0)	41 (21.3)	39 (14.0)
US	68 (80.0)	151 (78.7)	240 (86.0)

†The category “hepatitis C and ALD” was identified alone or in combination with other CLD etiologies.

‡Identified alone or in combination with other CLD etiologies.

§Identified in the absence of HCC.

¶Identified in the absence of cirrhosis.

Missing values were not included in percent calculations.

ALD, alcoholic liver disease; CLD, chronic liver disease; HCC, hepatocellular carcinoma; NH, non-Hispanic.