Impact of Hepatitis C Virus and Insurance Coverage on Mortality

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ABSTRACT

OBJECTIVES: To assess the association of payer status and mortality in hepatitis C virus (HCV)–infected patients.

STUDY DESIGN: For this retrospective observational study, we used the National Health and Nutrition Examination Survey from 2000 to 2010. Adults with complete data on medical questionnaires, HCV RNA, insurance types, and mortality follow-ups were included.

METHODS: We used Cox proportional hazards models to evaluate independent associations of insurance type with mortality in HCV-infected individuals. These models were rerun in the subset of HCV-positive subjects to determine the association of insurance type with mortality. The data used in this study predated the implementation of the Affordable Care Act.

RESULTS: Among 19,452 eligible participants, 311 (1.4%) were HCV positive. HCV-positive patients were older, were more likely to be non-Hispanic black and male, and had higher prevalence of hypertension (all P <.001). HCV-positive patients were also less likely to have private insurance and more likely to be covered by Medicaid or be uninsured relative to HCV-negative patients (P <.001). Among HCV-positive patients, after adjustment for confounders, those with Medicaid coverage had an increased risk of mortality compared with those with private insurance (hazard ratio [HR], 6.31; 95% CI, 1.22-29.94) and uninsured individuals (HR, 8.83; 95% CI, 1.56-49.99).

CONCLUSIONS: Patients who have HCV are more likely to be uninsured or covered by Medicaid. HCV-positive patients with Medicaid have an increased mortality risk compared with those with private insurance. Given the high burden of HCV infection and adverse prognosis among individuals covered by Medicaid, policy makers must prioritize funding and supporting Medicaid programs.

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In the United States, the estimated prevalence of individuals with hepatitis C virus (HCV) ranges from 5.2 million to 7.1 million.[1-3] The majority of individuals infected with HCV were born between 1945 and 1964—the generation known as baby boomers—but there has been an increase in the number of infected individuals younger than 30 years due to intravenous drug use, which has contributed to a bimodal age distribution of HCV burden.[4-6] If untreated, HCV can cause significant liver disease, making it the leading cause of cirrhosis, hepatocellular carcinoma, and liver transplantation in the United States.[7-10] Until recently, the standard treatment for HCV was interferon based and had low sustained virologic response (SVR) rates, resulted in frequent adverse effects, and impaired patients' health-related quality of life.[11-13] However, new treatment regimens containing direct-acting antivirals (DAAs) boast cure rates higher than 96% and improve health-related quality of life during treatment and post SVR.[14-17] Although the effectiveness of HCV treatment has steadily improved, these regimens have remained relatively expensive, with potential budgetary implications for payers.[18] This issue is especially important to the Medicare and Medicaid programs because of the high burden of HCV infection in their covered populations.[19,20] In fact, Medicare and Medicaid are currently the primary payers for the majority of HCV-associated cirrhosis hospitalizations.[21] With the aging of the baby boomers with HCV and the high prevalence of HCV in the Medicare and Medicaid populations, the future ability of these programs to cover the cost of the new and more costly anti-HCV treatments can be challenging.

It is important to note that in the United States, the affordability of healthcare, especially medications, is largely dependent on insurance type. Some types of insurance cover nearly all the up-front costs of medications, whereas others require individuals to pay large sums of money for out-of-pocket expenditures. In this context, it is possible that insurance type may influence health outcomes by creating potential barriers to accessing beneficial treatment.[19-22] This is especially relevant for the new anti-HCV regimens that have high efficacy but also substantial budgetary impact.[17] In fact, these up-front costs of covering the new anti-HCV medications have led

TAKEAWAY POINTS

- Hepatitis C virus (HCV) prevalence is significantly higher among patients with Medicaid compared with patients with private insurance and Medicare.
- Medicaid patients who are infected with HCV have a higher risk of all-cause mortality than HCV-positive patients with private insurance coverage.
- Policy makers should consider providing additional resources to Medicaid to cover all HCV-infected individuals.

to substantial access restrictions by some payers, especially some states' Medicaid programs.[23] In this context, it is possible that the characteristics of patients with HCV covered by different types of insurance, coupled with their ease of access to treatment regimens, could potentially affect their outcomes. Therefore, the aim of our analysis was to use National Health and Nutrition Examination Survey (NHANES) data and linked mortality files to assess the burden and outcomes of HCV infection according to insurance coverage types in the United States.

MATERIALS AND METHODS

Study Population

NHANES is a stratified, multistage probability sample representative of the noninstitutionalized civilian US population. The third NHANES was conducted in 1988-1994; beginning in 1999, the survey became a continuous program, with every 2 years representing 1 cycle. Each survey is composed of a home interview for demographic, socioeconomic, dietary, and health-related questions; a subsequent standardized physical examination; and laboratory tests from blood samples collected at a mobile examination center. Detailed descriptions of the plan and operation of each survey are available elsewhere.[24] We used data from 5 NHANES cycles (2001-2010). To determine NHANES participants' mortality status, we used the public-use Linked Mortality File, in which participants who were 18 years and older are linked to death records from the National Death Index through December 31, 2011.[25] The **eAppendix Figure** (eAppendix available at **ajmc.com**) represents the inclusion and exclusion criteria for the study population.

Collected Data and Definitions

Eligible participants were considered to have chronic hepatitis C (defined as HCV positive) if their serum tested positive for HCV RNA. Participants without HCV RNA were defined as HCV negative. Insurance types were categorized into 4 groups: (1) private insurance, including any military/state/government insurance; (2) Medicare; (3) Medicaid; and (4) uninsured. Patients with dual insurance (eg, private insurance and Medicare, Medicaid and Medicare) who could not be classified into a payer category were excluded. The following comorbidities were ascertained largely through the questionnaires completed by NHANES participants: history of arthritis, cancer, chronic obstructive pulmonary disease (COPD, which included either chronic bronchitis or emphysema), congestive heart disease (CHD), ischemic heart disease (IHD), kidney failure, and stroke.

Other clinical variables were defined as follows. Obesity was defined as a body mass index of 30 kg/m^2 or greater, and type 2 diabetes (T2D) was defined as a fasting glucose value of 126 mg/dL or greater or current use of oral hypoglycemic and/or insulin. A diagnosis of hypertension (HTN) required a mean systolic blood pressure of 140 mm Hg or greater, mean diastolic blood pressure of 90 mm Hg or greater, or current use of an antihypertensive. Hypercholesterolemia was defined as a total serum cholesterol of 200 mg/dL or greater, a low-density lipoprotein of 130 mg/dL or greater, current use of an antihyperlipidemic drug, or a high-density lipoprotein (HDL) of 40 mg/dL or less in men or 50 mg/dL or less in women. A diagnosis of metabolic syndrome was defined as having at least 3 of the following[26]: waist circumference greater than 102 cm in men or 88 cm in women, fasting plasma glucose greater than 110 mg/dL, blood pressure greater than 130/85 mm Hg, elevated triglycerides greater than 150 mg/dL, and HDL of 40 mg/dL or less in men or 50 mg/dL or less in women.

Participants' age, race/ethnicity, sex, military service, college degree, marital status, employment, excessive alcohol consumption (if more than 20 g per day in men and more than 10 g per day in women), smoking status, and poverty income ratio (PIR) were based on self-reported data from the NHANES in-home interview.

Of note, the data used in this study predated the implementation of the Affordable Care Act (ACA).

Statistical Analysis

Sampling weights provided by the National Center for Health Statistics (NCHS) were used to account for survey nonresponse and sampling strategy. For national representation, original weights in our merged sample were modified using the method recommended by NCHS.[25] Sampling errors were estimated by the Taylor linearization method using subpopulation (domain) analysis. Variables were expressed as weighted means or weighted percentages (standard errors). Differences between groups were evaluated using a *t* statistic for continuous variables and the Rao-Scott χ^2 test for categorical variables. Age adjustment estimates were calculated by the direct method to the standard 2000 United States population estimates using the age groups of 18 to 44 years, 45 to 54 years, 55 to 64 years, and 65 years or older.

Among HCV-positive individuals, weighted all-cause mortality rates were stratified by types of insurance. The Cox models were implemented in the HCV-positive subjects to determine the association of insurance type with all-cause mortality adjusting for important covariates. We used 2 models: Model 1 adjusted for sociodemographics including age, gender, race, PIR, education, and marital status, and model 2 adjusted for the sociodemographic

and clinical variables selected by bidirectional stepwise regression. The proportional hazards assumptions of the Cox models were examined by testing time-dependent covariates.[27] All analyses were performed with SAS software, version 9.4 (SAS Institute; Cary, North Carolina).

RESULTS

Characteristics of Study Population

After applying exclusion criteria, 19,452 individuals from 5 NHANES cycles (2001-2010) were considered eligible for this study (eAppendix Figure). Mean age was 43.3 years, 48% were male, and 69.5% were non-Hispanic white, 11.2% were non-Hispanic black, 13.6% were Hispanic, and 5.8% were of other racial background (**Table 1**). Of the 19,452, 311 individuals (weighted prevalence of HCV, 1.37%; 95% CI, 1.15%-1.59%) had detectable HCV RNA. In terms of comorbidities, 33.2% were obese, 7.4% had T2D, 68.5% had hypercholesterolemia, 30.4% had HTN, and 16.6% had metabolic syndrome (Table 1). Additionally, 68.3% had private insurance, 5.8% had Medicare, 4.3% had Medicaid, and 21.7% had no insurance (**Table 2**). The age-adjusted prevalence of HCV was highest among individuals with Medicaid (2.58%), followed by the uninsured (2.17%), those with Medicare (1.24%), and those with private insurance (0.81%) (**Figure** and **eAppendix Table 1**).

TABLE 1. Demographic and Clinical Parameters of HCV-Positive and HCV-Negative Subjects[a,b]

Characteristics	HCV-Positive (n = 311)	HCV-Negative (n = 19,141)	*P*	All
Age, years, mean (SE)	48.06 (0.47)	43.26 (0.20)	<.0001	43.32 (0.20)
Race, % (SE)				
Non-Hispanic white	64.58 (3.49)	69.52 (1.48)	.1163	69.46 (1.47)
Non-Hispanic black	22.06 (2.65)	11.01 (0.75)	<.0001	11.16 (0.75)
Hispanic	9.99 (1.94)	13.64 (1.08)	.0711	13.59 (1.07)
Other race	3.36 (1.27)	5.83 (0.43)	.1479	5.79 (0.42)
Male, % (SE)	65.67 (3.30)	48.15 (0.34)	<.0001	48.39 (0.34)
Married, % (SE)	38.73 (2.96)	58.33 (0.69)	<.0001	58.06 (0.68)
Employed, % (SE)	60.03 (3.15)	72.37 (0.53)	<.0001	72.20 (0.53)
Smoker, % (SE)	84.41 (2.88)	46.47 (0.73)	<.0001	46.99 (0.72)
PIR,[c] mean (SE)	2.16 (0.11)	3.09 (0.03)	<.0001	3.08 (0.03)
Comorbidities, % (SE)				
Obesity	22.08 (2.81)	33.31 (0.61)	.0006	33.16 (0.60)
Diabetes	10.65 (2.39)	7.39 (0.26)	.1110	7.43 (0.25)
Hypercholesterolemia	53.07 (4.28)	68.7 (0.50)	<.0001	68.49 (0.51)
Hypertension	40.00 (3.27)	30.28 (0.55)	.0014	30.41 (0.55)
Metabolic syndrome	13.63 (2.64)	15.62 (0.42)	.4768	15.59 (0.42)
History, % (SE)				
Arthritis	32.43 (3.23)	19.15 (0.47)	<.0001	13.25 (0.34)
Cancer	7.60 (1.78)	6.19 (0.26)	.3965	6.21 (0.26)
Congestive heart disease	3.87 (1.30)	1.24 (0.09)	.0006	1.28 (0.09)
COPD	13.16 (2.39)	5.96 (0.28)	<.0001	6.06 (0.28)
Ischemic heart disease	3.48 (1.02)	3.79 (0.17)	.7698	3.79 (0.17)
Kidney failure	4.95 (1.58)	1.37 (0.08)	<.0001	1.42 (0.08)
Stroke	3.13 (1.13)	1.58 (0.11)	.0452	1.60 (0.11)

COPD indicates chronic obstructive pulmonary disease; HCV, hepatitis C virus; PIR, poverty income ratio; SE, standard error.

[a]Participants with dual insurance were excluded.

[b]All values are displayed as weighted percentage (SE) except where otherwise noted.

[c]Higher PIR reflects better economic status.

Comparison of HCV-Positive Cohort With the HCV-Negative Controls

The results of the comparison between the HCV-positive cohort and HCV-negative controls are summarized in Table 1. The mean age of HCV-positive subjects was 48.1 years, 64.6% were non-Hispanic white, and 65.7% were male. As expected, relative to HCV-negative subjects, those with HCV were older and more likely to be male, non-Hispanic black, and unmarried. HCV-positive patients were less likely to be employed and had lower income (all P <.05). Additionally, HCV-positive participants had significantly higher prevalence of HTN and of history of arthritis, COPD, congestive heart disease, kidney failure, and stroke (P <.05) (Table 1). Compared with HCV-negative controls, HCV-positive subjects were more likely to be covered by Medicaid or be uninsured and less likely to have private insurance (Table 2).

TABLE 2. Insurance Coverage in HCV-Positive and HCV-Negative Subjects[a,b]

	HCV-Positive	HCV-Negative	*P*	All
Insurance coverage, % (SE)	61.20 (4.00)	78.7 (0.62)	<.0001	78.46 (0.63)
Insurance type, % (SE)				
Private[c]	48.26 (3.68)	68.54 (0.68)	<.0001	68.26 (0.69)
Medicare	4.05 (0.90)	5.81 (0.25)	.1061	5.79 (0.25)
Medicaid	8.70 (1.75)	4.22 (0.23)	.0003	4.28 (0.23)
Uninsured, % (SE)	38.99 (4.06)	21.43 (0.62)	<.0001	21.67 (0.63)

HCV indicates hepatitis C virus; SE, standard error.

[a]Participants with dual insurance were excluded.

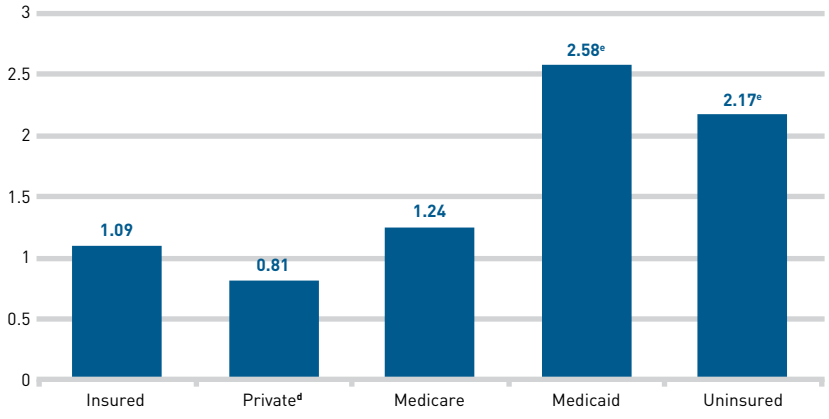
[b]All values are displayed as weighted percentage (SE).

[c]Includes any military/state/government insurance.

Comparison of HCV-Positive Cohort Across Insurance Types

There were significant differences in sociodemographics and comorbid conditions according to type of insurance. Compared with

FIGURE. Age-Adjusted Prevalence of HCV Infection Among Adults 18 Years or Older, by Insurance Type: NHANES, 2000-2010[a,b,c]



HCV indicates hepatitis C virus; NHANES, National Health and Nutrition Examination Survey.

[a]Participants with dual insurance were excluded.

[b]Age adjustment estimates were calculated by the direct method to the standard 2000 US population estimates using the age groups of 18 to 44 years, 45 to 54 years, 55 to 64 years, and 65 years or older.

[c]Crude estimates of HCV prevalence are 1.07% for insured overall, 0.97% for private, 0.96% for Medicare, 2.79% for Medicaid, and 2.47% for uninsured.

[d]Includes any military/state/government insurance.

[e]Significantly different from private (P <.05).

HCV-positive patients with private insurance, those with Medicare or Medicaid insurance were less likely to be non-Hispanic white and more likely to be non-Hispanic black, be unmarried, and have lower income (P <.05 for each comparison) (**Table 3**).

As expected, HCV-positive patients with Medicare were older, more likely to be non-Hispanic black, and more likely to have comorbidities such as HTN and T2D, as well as history of arthritis, cancer, CHD, IHD, kidney failure, and stroke, compared with those with private insurance or the uninsured.

Also, HCV-positive patients with Medicaid had higher rates of obesity (41.9% vs 20.1% among Medicare and 12.0% among uninsured), T2D (27.4% vs 10.0% among private and 6.7% among uninsured), HTN (52.9% vs 34.6% among uninsured), metabolic syndrome (32.9% vs 14.9% among private and 6.6% among uninsured), arthritis (46.4% vs 27.0% among private), CHD (7.4% vs 3.8% among private and 1.9% among uninsured), and IHD (8.0% vs 1.6% among private) (Table 3).

Compared with other patients, HCV-positive patients with private insurance were more likely to have high income and to be non-Hispanic white, married, and employed.

Finally, the uninsured HCV-positive patients were younger, had lower income, and had lower rates of comorbid conditions compared with the insured HCV-positive patients (data not shown).

All-Cause Mortality Among HCV-Positive Cohort Across Insurance Types

In this subgroup analysis, only participants with HCV (n = 311) were included. Through the follow-up period (median, 58 months), there were significant differences in all-cause mortality rates across insurance types. Weighted unadjusted all-cause mortality was the highest among patients with Medicare (45.4%), followed by Medicaid (23.7%), private (7.9%), and uninsured (6.8%) (**Table 4**). However, after adjusting for sociodemographic variables, HCV-positive patients with Medicaid had significantly higher all-cause mortality compared with HCV-positive patients with private insurance (hazard ratio [HR], 5.81; 95% CI, 1.15-29.29) and the uninsured (HR, 5.01; 95% CI, 1.19-21.01). In fact, even after adjustments by stepwise selection, the model still indicated that those with Medicaid had an increased risk of mortality compared with those with private insurance (HR, 6.31; 95% CI, 1.22-29.94) and the uninsured (HR, 8.83; 95% CI, 1.56-49.99) (Table 4).

DISCUSSION

Our study reveals that among the NHANES population, the prevalence of HCV is quite high among individuals who are covered by Medicare and Medicaid and among the uninsured population.

Additionally, our analysis showed that presence of HCV infection is an independent risk factor for mortality (**eAppendix Table 2**) and that the risk further increases in the subgroup of HCV-infected individuals who are covered by Medicare or Medicaid—specifically, those covered by Medicaid (Table 4). To our knowledge, this is the first study to document an association between mortality and Medicaid coverage in HCV-infected subjects using a population-based database.

When assessing the mortality of patients enrolled in this NHANES-based analysis, we also confirmed some of the other well-known risk factors for mortality. Those factors include HCV status, age, smoking status, comorbidities, and some sociodemographic components, such as income level (eAppendix Table 2). These findings have also been reported in previous studies and are reflected in our results supporting the validity of our analyses.[28-32] Specifically, our data analysis shows that HCV infection is an independent risk factor for mortality, as HCV-infected individuals are nearly twice as likely to experience mortality as HCV-negative individuals. Numerous studies have examined and confirmed this increased risk of mortality in HCV-positive subjects.[33-35] A CDC report highlights that the HCV deaths in the United States have now surpassed deaths from 60 other infectious conditions combined.[35] Furthermore, El-Kamary et al demonstrated that HCV all-cause mortality is more than twice that of HCV-negative individuals, indicating that HCV-positive individuals are at a higher risk of death even after accounting for liver-related morbidity.[33] Also, Sayiner et al concluded that among Medicare recipients, a diagnosis of HCV is independently associated with higher mortality.[34]

Additionally, our study found that among the entire study population, those with Medicaid had an increased risk of all-cause mortality. This was confirmed after adjustment for confounders. Several other studies have reported an association between insurance type and negative health outcomes.[36-41] Saunders et al examined a nationally representative sample of individuals with albuminuria and concluded that lack of insurance and having public insurance such as Medicaid were both associated with increased mortality compared with private insurance, even after controlling for numerous variables.[36] Furthermore, a nationally representative study of Americans hospitalized for myocardial infarction, stroke, or pneumonia found significantly lower in-hospital mortality for privately insured patients relative to the uninsured or to Medicaid recipients.[38] Similarly, multiple studies assessing cancer survival and insurance status concluded that the uninsured and those with Medicaid experienced shorter survival relative to those with all other types of insurance.[39-45]

The exact reasons for this increased mortality in HCV-positive patients with Medicaid are not known but could potentially be related to other confounders that are not captured by these databases. These factors could include health literacy about HCV, access to preventive services, access to specialized care for HCV, number of HCV treatment providers who accept Medicaid patients, and other barriers to screening for HCV and linkage to appropriate care.

Regardless of the reasons for the adverse outcomes, our analysis provides evidence to support the conundrum faced by many Medicaid recipients and Medicaid programs in the United States. These programs cover populations that not only have high prevalence of HCV but also are at increased risk for mortality. In fact, our data show that HCV-infected individuals with Medicaid were nearly 10 times more likely to experience mortality compared with HCV-infected individuals who are covered by private insurance, and this risk was independent of a large number of confounders. The fiscal and ethical challenges of facing the combination of high prevalence and high mortality of HCV are a double-edged sword for Medicaid programs. In this context, it is important that Medicaid programs are funded appropriately to deal with this ongoing major challenge.

It is important to note that our study examined data only up to 2010, the same year the ACA was signed into law. This major reform changed the healthcare landscape in the United States, in particular by increasing the number of Americans covered by Medicaid.[46] This is especially important because our data show the highest prevalence of HCV in the uninsured. As these individuals are increasingly being covered through Medicaid expansion, the burden of HCV to Medicaid will certainly increase. Also, after 2011, treatment for HCV improved dramatically with the development of DAAs.[47,48] Consequently, a record number of people could become candidates for these highly effective HCV treatment options with minimal adverse events.[14] Despite this high efficacy, there is evidence that Medicaid programs are not able to cope with anti-HCV treatment coverage and some programs have created substantial barriers to treatment.[17,23,49] Given the time frame of our study, we are not able to assess the impact of Medicaid expansion or new antiviral regimens on the mortality of patients with HCV covered by Medicaid. Nevertheless, the increasing number of HCV-infected individuals covered through Medicaid expansion

TABLE 3. Demographic and Clinical Parameters of HCV-Positive Subjects, by Insurance Type[a,b]

	Private[c] (n = 132)	Medicare (n = 26)	Medicaid (n = 39)	Uninsured (n = 114)
Age, years, mean (SE)	48.79 (0.60)[d,e]	62.66 (1.60)[e,f,g]	45.41 (1.05)[d]	46.24 (0.36)[d,f]
Race, % (SE)				
Non-Hispanic white	67.53 (3.71)[d,g]	37.11 (10.72)[e,f]	43.99 (8.17)[e,f]	68.39 (4.35)[d,g]
Non-Hispanic black	17.35 (2.34)[d,g]	42.85 (10.10)[e,f]	38.26 (8.55)[e,f]	22.12 (4.05)[d,g]
Hispanic	10.53 (2.55)	13.70 (5.66)	11.46 (4.60)	8.61 (2.02)
Other race	4.59 (1.72)[e]	6.35 (1.09)[e]	6.29 (3.86)[e]	0.88 (0.90)[d,f,g]
Male, % (SE)	67.81 (4.64)	58.57 (9.20)	57.83 (9.19)	65.50 (4.13)
Married, % (SE)	46.61 (3.80)[d,g]	18.18 (6.99)[f]	22.97 (6.97)[f]	34.63 (4.30)
Employed, % (SE)	74.52 (4.14)[d,e,g]	2.72 (2.75)[e,f,g]	23.92 (7.92)[d,e,f]	56.11 (4.41)[d,f,g]
Smoker, % (SE)	79.19 (3.79)[e,g]	80.10 (8.35)	89.28 (4.38)[f]	90.22 (2.51)[f]
PIR, mean (SE)	2.90 (0.14)[d,e,g]	1.30 (0.12)[f]	1.30 (0.12)[f]	1.48 (0.07)[f]
Comorbidities, % (SE)				
Obese	27.10 (3.79)[e]	20.49 (5.39)[e,g]	41.86 (9.62)[d,e]	11.95 (2.71)[d,f,g]
Diabetes	10.04 (2.48)[g]	20.74 (7.09)[e]	27.43 (10.14)[e,f]	6.70 (1.81)[d,g]
Hypercholesterolemia	58.73 (4.68)	47.86 (10.84)	60.90 (9.36)	44.88 (6.03)
Hypertension	39.80 (4.49)[d]	67.27 (7.69)[e,f]	52.88 (8.31)[e]	34.58 (4.97)[d,g]
Metabolic syndrome	14.89 (3.26)[e,g]	25.02 (7.46)[e]	32.92 (8.04)[e,f]	6.57 (1.86)[d,f,g]
History, % (SE)				
Arthritis	27.03 (4.05)[d,g]	71.98 (9.21)[e,f,g]	46.35 (8.56)[d,f]	31.89 (4.09)[d]
Cancer	9.50 (1.82)[e]	17.68 (7.03)[e,g]	4.86 (2.31)[d]	4.82 (1.79)[d,f]
COPD	16.23 (3.73)[d]	5.18 (2.77)[f]	9.47 (4.68)	10.90 (3.16)
Congestive heart disease	3.82 (1.80)[d]	15.89 (6.48)[e,f,g]	7.39 (3.44)[d,e]	1.89 (1.22)[d,f]
Ischemic heart disease	1.55 (0.88)[d,g]	20.19 (5.75)[e,f,g]	8.01 (3.80)[d,f]	3.11 (1.50)[d]
Kidney failure	3.85 (1.09)[d]	12.14 (5.20)[f,g]	2.99 (2.88)[d]	6.01 (2.75)
Stroke	2.90 (0.73)[d]	12.02 (3.89)[e,f,g]	2.99 (2.88)[d]	2.52 (1.49)[d]

COPD indicates chronic obstructive pulmonary disease; HCV, hepatitis C virus; PIR, poverty income ratio; SE, standard error.

[a]Participants with dual insurance were excluded.

[b]All values are displayed as weighted percentage (SE) except where otherwise noted.

[c]Includes any military/state/government insurance.

[d]Significantly different from Medicare (P <.05).

[e]Significantly different from uninsured (P <.05).

[f]Significantly different from private (P <.05).

[g]Significantly different from Medicaid (P <.05).

TABLE 4. All-Cause Mortality Among HCV-Positive Subjects, by Insurance Type[a]

		Model 1[b]		Model 2[c]	
	Mortality %	HR (95% CI)	*P*	HR (95% CI)	*P*
Private[d]	7.88[e,f]	Reference		Reference	
Medicare	45.43[g,h]	5.71 (0.26-125.30)	.2618	3.19 (0.38-26.92)	.2571
Medicaid	23.72[g,h]	5.81 (1.15-29.29)	.0337	6.31 (1.22-29.94)	.0172
Uninsured	6.79[e,f]	1.13 (0.24-5.22)	.8750	0.71 (0.26-1.98)	.9324

HCV indicates hepatitis C virus; HR, hazard ratio; PIR, poverty income ratio.

[a]Participants with dual insurance were excluded.

[b]Model 1: Adjusted for sociodemographics, including age, gender, race/ethnicity, PIR, education, and marital status. Compared with uninsured, Medicaid beneficiaries experienced higher mortality (HR, 5.01; 95% CI, 1.19-21.01).

[c]Model 2: Bidirectional stepwise selection considering all demographic and clinical variables was performed. Compared with uninsured, Medicaid beneficiaries experienced higher mortality (HR, 8.83; 95% CI, 1.56-49.99).

[d]Includes any military/state/government insurance.

[e]Significantly different from Medicare (P <.05).

[f]Significantly different from Medicaid (P <.05).

[g]Significantly different from private (P <.05).

[h]Significantly different from uninsured (P <.05).

and restrictions in providing treatment regimens could have exacerbated the problem. In this context, it is important that future studies assess outcomes in the Medicaid population after these recent changes.

Limitations

Our study has several limitations. NHANES collects insurance type at the time of interview without any validation. If types of insurance were misclassified, it might dilute the true effect on mortality in our sample. This is important because the reported prevalence of Medicaid and Medicare recipients in our study is smaller than in the general population for the study period.[50] After the interview, the gain or loss of coverage was not measurable. Furthermore, NHANES does not have data regarding the duration of insurance coverage or the amount of cost sharing (out-of-pocket expenses) experienced by the participants. Also, this analysis included a time period that predates ACA legislation in the United States. The impact of the insurance expansion through ACA must be analyzed in the future. Lastly, we excluded dually eligible individuals from our study because they were classified as having 2 types of insurance. We believe this exclusion had a minimal effect because this cohort included fewer than 1% of NHANES participants from 2000 to 2010. Nevertheless, our analysis still produced a number of results that are supported by the literature, indicating the validity of our analytic approach.

CONCLUSIONS

Our data show that HCV-infected individuals are at twice the risk for mortality. Additionally, patients with Medicaid had higher mortality than privately insured patients with HCV. In fact, having Medicaid coverage in HCV-infected patients independently contributed to the mortality outcomes. Given the high prevalence of HCV in the Medicaid population and their increased risk of mortality (both related to HCV and Medicaid coverage), these patients require special attention. Now that the availability of highly effective treatment regimens is wider, access to these regimens for the Medicaid population with HCV is urgently needed. In this context, it is critical that policy makers provide adequate resources to Medicaid programs to deal with this urgent need. Further research is warranted to assess the impact of the ACA, new antiviral regimens, and recent changes in the payer coverage restrictions for HCV treatment on the coverage and completion of treatment among these HCV-infected patients. ■

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eAppendix Table 1. Age Adjusted Prevalence of HCV Infection Among Adults Aged 18 or Older, by Type of Insurance

	Crude %, (95% CI)	**Age adjusted %, (95% CI)**
Insured	1.07 (0.86 - 1.27)	1.09 (0.89 - 1.30)
Insurance type		
Private*	0.97 (0.76 - 1.19)	0.81 (0.53 - 1.08)
Medicare	0.96 (0.55 - 1.37)	1.24 (0.48 - 1.99)
Medicaid	2.79 (1.73 - 3.85)[1,2]	2.58 (1.52 - 3.65)[1]
Uninsured	2.47 (1.80 - 3.14)[1,2]	2.17 (1.63 - 2.71)[1]

Participants with dual insurance were excluded.

Age adjustment estimates were calculated by the direct method to the standard 2000 US population estimates using the age groups of 18 to 44 years, 45 to 54 years, 55 to 64 years, and 65 years or older.

* includes any military/state/government insurance.

[1] Significantly different from Private ($p<.05$)

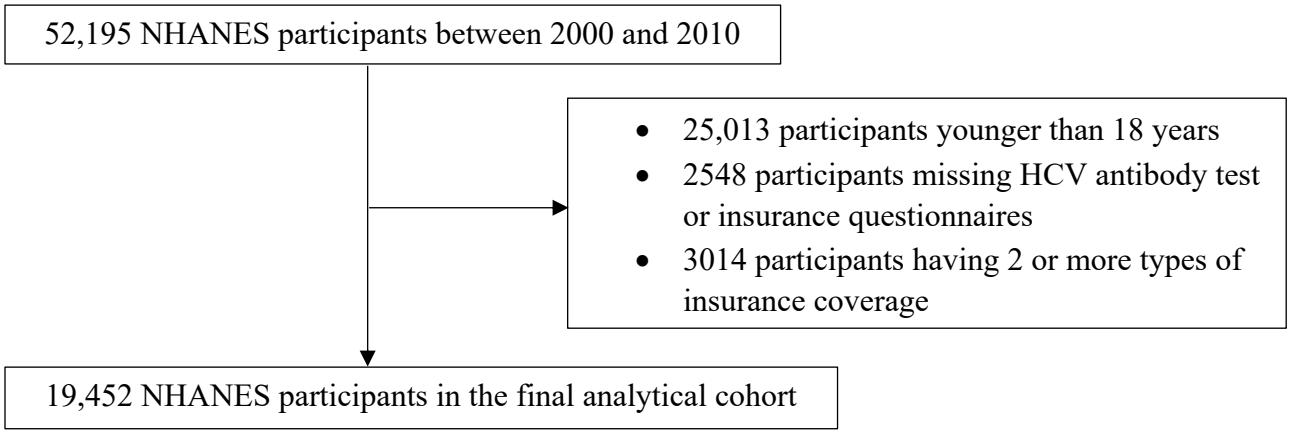
[2] Significantly different from Medicare ($p<.05$)

eAppendix Table 2. Independent Predictors of All Cause Morality in the Study Population (N=16,122)

	HR (95% CI)	P-value
HCV	1.93 (1.12-3.33)	0.019
Covariate		
White (REF)	1	
Black	1.04 (0.83-1.31)	0.7084
Mexican	1.01 (0.79-1.3)	0.9094
Other	0.74 (0.43-1.25)	0.2564
Smoker	1.56 (1.24-1.96)	0.0002
Married	0.68 (0.54-0.84)	0.0007
College degree	0.65 (0.48-0.87)	0.0045
Income poverty ratio	0.97 (0.89-1.06)	0.4403
Comorbidities		
Obese	1.23 (0.88-1.72)	0.2134
Diabetes	1.61 (1.22-2.12)	0.001
Hypercholesterolemia	0.99 (0.76-1.29)	0.9222
Hypertension	1.51 (1.14-1.99)	0.0041
Metabolic Syndrome	0.73 (0.47-1.15)	0.1724
Asthma	1.19 (0.9-1.56)	0.216
Arthritis	0.92 (0.73-1.15)	0.4403
Cancer	1.64 (1.28-2.1)	0.0001
COPD	1.05 (0.77-1.44)	0.7366
Congestive Heart Disease	1.66 (1.12-2.45)	0.0115
Ischemic Heart Disease	0.94 (0.71-1.24)	0.672
Kidney Failure	1.85 (1.2-2.84)	0.0057
Stroke	2.32 (1.26-4.25)	0.0072

HR= adjusted Hazard Ratio and 95% CI =95% confidence interval

eAppendix Figure. Study Flow of the Analytical Cohort Selection From NHANES



HCV indicates hepatitis C virus; NHANES, National Health and Nutrition Examination Survey.