National Estimates of Healthcare Utilization by Individuals With Hepatitis C Virus Infection in the United States

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Background. Hepatitis C virus (HCV) infection is a major public health problem in the United States. Although prior studies have evaluated the HCV-related healthcare burden, these studies examined a single treatment setting and did not account for the growing "baby boomer" population (individuals born during 1945–1965).

Methods. Data from the National Ambulatory Medical Care Survey, the National Hospital Ambulatory Medical Care Survey, and the Nationwide Inpatient Sample were analyzed. We sought to characterize healthcare utilization by individuals infected with HCV in the United States, examining adult (≥18 years) outpatient, emergency department (ED), and inpatient visits among individuals with HCV diagnosis for the period 2001–2010. Key subgroups included persons born before 1945 (older), between 1945 and 1965 (baby boomer), and after 1965 (younger).

Results. Individuals with HCV infection were responsible for >2.3 million outpatient, 73 000 ED, and 475 000 inpatient visits annually. Persons in the baby boomer cohort accounted for 72.5%, 67.6%, and 70.7% of care episodes in these settings, respectively. Whereas the number of outpatient visits remained stable during the study period, inpatient admissions among HCV-infected baby boomers increased by >60%. Inpatient stays totaled 2.8 million days and cost >$15 billion annually. Nonwhites, uninsured individuals, and individuals receiving publicly funded health insurance were disproportionately affected in all healthcare settings.

Conclusions. Individuals with HCV infection are large users of outpatient, ED, and inpatient health services. Resource use is highest and increasing in the baby boomer generation. These observations illuminate the public health burden of HCV infection in the United States.

Keywords. emergency department; healthcare utilization; hepatitis C; infectious disease; screening.

Hepatitis C virus (HCV) infection poses a major and growing public health problem. An estimated 3.2 million Americans are currently living with chronic HCV infection [1]. HCV infection is particularly prevalent in the "baby boomer" population (those born between 1945 and 1965). Prior studies estimate that 3.3% of baby boomers are HCV antibody positive, and this birth cohort accounts for up to 75% of all HCV infections in the United States [2]. Additionally, 43%–85% of baby boomers are unaware of their HCV infection status [3–5]. Chronic HCV infection remains the leading cause of chronic liver disease, hepatocellular carcinoma, and liver transplant [6]. In 2007, mortality from HCV eclipsed that of human immunodeficiency virus (HIV) in the United States and is expected to rise over the coming decades [7].

Although much is known about the disease course of individuals with HCV infection, little is known about their collective impact upon the US healthcare system. Prior studies of HCV healthcare utilization have been limited to single centers or treatment settings [8, 9]. Because the chronic nature of HCV may result in healthcare utilization in outpatient, emergency department

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(ED), and inpatient settings, efforts to estimate the national healthcare burden of HCV must account for all 3 treatment arenas. Few studies describe the comparative rates or patterns of healthcare utilization by HCV individuals in these settings. This information is particularly important given that HCV primarily affects the baby boomer generation [10].

Our objective was to determine the characteristics of the outpatient, ED, and inpatient healthcare utilization by persons with HCV infection in the United States.

METHODS

Study Design and Setting

We analyzed data from the National Ambulatory Medical Care Survey (NAMCS), the National Hospital Ambulatory Medical Care Survey (NHAMCS), and the Nationwide Inpatient Sample (NIS). The study was approved by the institutional review board of the University of Alabama at Birmingham.

Data Sources

We obtained outpatient data from the NAMCS and the NHAMCS for outpatient departments (NHAMCS-OPD). Operated by the National Center for Health Statistics (NCHS), the NAMCS is a national survey examining visits to physicians' offices. The NAMCS samples geographic areas, physicians within these areas, and patient visits within practices to produce nationally representative samples annually [11]. The NHAMCS is a national probability sample characterizing ED (NHAMCS-ED) and outpatient clinic (NHAMCS-OPD) visits at hospitals across the United States. Using a 4-stage probability design, NHAMCS-ED samples geographically defined areas, hospitals within these areas, emergency service areas within the EDs of the hospitals, and patient visits to the emergency services areas [12]. NHAMCS-OPD uses a similar design, sampling geographic areas, hospitals within these areas, clinics within outpatient departments, and visits to the clinics [12].

For an assigned 4-week period, NAMCS and NHAMCS systematically select all patients from selected facilities. The NCHS works with each hospital and clinic to abstract clinical data from selected charts. For this study, we used NAMCS and NHAMCS public-use data for the 10-year period 2001–2010. Visits were classified as outpatient if presenting to a physician's office or outpatient clinic (NAMCS or NHAMCS-OPD), consistent with prior efforts utilizing these data sources [13].

We obtained inpatient data from the NIS, Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality. The NIS is a comprehensive database of sampled inpatient hospital stays from across the United States. The 2010 NIS includes 1051 hospitals in 45 states, which cover >96% of the US population [14]. Each year, data are collected on approximately 8 million inpatient hospital stays [14].

Selection of Participants

We studied adult (≥18 years) patients with a diagnosis of HCV infection. We defined the population as individuals with outpatient, ED, or inpatient diagnoses consistent with HCV infection. The outpatient and ED data contained up to 3 diagnoses, and the inpatient data included up to 25 diagnoses. *International Classification of Diseases, Ninth Revision* (*ICD-9*) diagnosis codes for HCV included 70.41, 70.44, 70.51, 70.54, 70.70, 70.71, and V02.62. We stratified all HCV individuals into 3 birth cohorts: older (individuals born before 1945), baby boomer (those born between 1945 and 1965), and younger (those born after 1965). We additionally classified visits and discharges as involving a liver-related complication if they had diagnoses of chronic liver disease or cirrhosis (*ICD-9*: 571), liver abscess and sequelae of chronic liver disease (572), other disorders of the liver (573), ascites (789.5), esophageal varices (456.00–456.21), hepatocellular carcinoma (155.0 and 155.2), or hepatorenal syndrome (674.8) [13].

Demographics and Clinical Characteristics

For each visit and discharge, we identified patient characteristics (year of encounter, race, ethnicity, sex, insurance status, geographic region, population setting, and median household income for patient's ZIP code [NIS only]) and primary diagnosis. We also identified the total charge and length of stay for inpatient hospitalizations. Because of missing values for sex (1.6% of outpatient visits, 0.8% of ED visits, and 0.2% of inpatient discharges) and race (18.1% of outpatient visits, 10.5% of ED visits, and 23.5% of inpatient discharges), we used imputed variables provided by the respective data sets [11, 12]. We classified insurance as Medicare, Medicaid, private, self-pay or other insurance, using the hierarchy recommended by NAMCS and NHAMCS [11, 12]. We also categorized insurance as private, public (Medicare/Medicaid), and self-pay. We defined geographic region by census region. Data pertaining to ethnicity (NAMCS and NHAMCS) and household income (NIS) were not available for 2001 or 2002.

Data Analysis

We reported descriptive statistics, utilizing sampling design and weight variables to calculate nationally weighted estimates and corresponding 95% confidence intervals. Because the NCHS considers estimates with >30% relative standard error or based on <30 raw observations to be unreliable, we collapsed subcategories accordingly. For variance and 95% confidence interval calculations, we used ultimate cluster design (single stage sampling), utilizing stratum and primary sampling unit identifiers provided with the NAMCS and NHAMCS data sets [11, 12, 15]. We used a similar approach for NIS data, making use of discharge weight and sampling variables.

We assessed differences in characteristics using χ^2 tests of association corrected for the complex sampling design. We determined temporal trends in HCV encounters by including year as a continuous variable in logistic regression models. To obtain more precise variance estimates, we used 2-year temporal intervals for NAMCS and NHAMCS. Means and confidence intervals were reported for continuous measures, with the exception of charge data. Due to the highly skewed distribution, medians and interquartile ranges (IQRs) were reported for inpatient charges. We used the Consumer Price Index for inpatient services and adjusted to the value of the US dollar in 2010 for all inpatient charge calculations, assessing trends by calculating the percentage of change over the study period [16]. All analyses were conducted using Stata software, version 12.1 (StataCorp, College Station, Texas).

RESULTS

Characteristics of Outpatient Visits

Among 824 million annual adult outpatient visits from 2001 to 2010, individuals with HCV infection accounted for 2.29 million visits (0.28%; 95% confidence interval [CI], .22%–.34%). Baby boomers accounted for almost three-fourths of outpatient visits by HCV-infected individuals (Table 1). Compared with visits by non-HCV-infected baby boomers, HCV-infected baby boomers visiting the outpatient setting were disproportionately male (69.9% vs 40.0%; $P < .001$), black (29.5% vs 11.4%; $P < .001$), and insured by Medicaid (25.9% vs 7.0%; $P < .001$) (Table 2). Over the 10-year study period, there was no change in the percentage of outpatient visits for HCV (trend $P = .182$) (Figure 1). Liver-related complications occurred in 3.5%, 7.6%, and 10.0% of the younger, baby boomer, and older cohorts, respectively.

Characteristics of ED Visits

Among 90 million annual adult ED visits, individuals with HCV infection accounted for 72 138 (0.08%; 95% CI, .07%–.10%). Baby boomers accounted for 67.7% of ED visits by HCV-infected persons (Table 1). Compared with visits by non-HCV-infected baby boomers, HCV-infected persons visiting the ED were disproportionately male (62.1% vs 46.9%; $P < .001$), of Hispanic ethnicity (19.4% vs 10.6%; $P = .011$), and insured by Medicaid (42.1% vs 16.8%; $P < .001$) (Table 2). There were no trends in the percentage of ED visits for HCV among baby boomers (trend P value = .519; Figure 1). The proportion of visits among individuals with a liver-related complication was smallest for the younger cohort (5.2%). For the others, the proportion was elevated, with 16.6% of the baby boomer cohort and 26.3% of the older cohort having a complication.

Characteristics of Inpatient Discharges

Among 31.8 million annual adult inpatient discharges, HCV-infected persons accounted for 475 224 (1.5%; 95% CI, 1.4%–1.5%).The baby boomer cohort accounted for 70.7% of inpatient discharges among HCV-infected persons (Table 1). Inpatient discharge for HCV increased by 60% for the baby boomer cohort, rising from 2.6% in 2001 to 4.2% in 2010 (trend $P < .001$; Figure 2*A*). Compared with discharges of non-HCV-infected baby boomers, those with HCV infection were disproportionately male (66.1% vs 47.1%; $P < .001$), insured by Medicaid (35.1% vs 16.0%; $P < .001$), and residents

Table 1. Annual Healthcare Encounters for Persons With Hepatitis C Infection, Stratified by Age Cohort and Setting, 2001–2010

	Outpatient Visits[a]		ED Visits[b]		Inpatient Discharges[c]	
Cohort	No HCV No. (1000s) % (95% CI)	HCV No. (1000s) % (95% CI)	No HCV No. (1000s) % (95% CI)	HCV No. (1000s) % (95% CI)	No HCV No. (1000s) % (95% CI)	HCV No. (1000s) % (95% CI)
All adults	824 347	2290	89 880	72	31 788	475
Younger (born after 1965)[d]	216 157 26.2 (25.4–27.0)	330 14.4 (10.5–19.4)	41 171 45.8 (45.1–46.5)	15 20.4 (14.9–27.3)	8318 26.2 (25.7–26.6)	76 16.0 (15.3–16.6)
Baby boomer (born 1945–1965)	308 137 37.4 (36.9–37.9)	1659 72.5 (67.2–77.2)	28 503 31.7 (31.3–32.1)	49 67.6 (59.7–74.7)	8683 27.3 (27.1–27.6)	336 70.7 (70.3–71.2)
Older (born before 1945)	300 052 36.4 (35.4–37.4)	301 13.2 (8.1–20.8)	20 206 22.5 (21.9–23.1)	9[e] 12.0 (NA)	14 787 46.5 (46.0–47.1)	63 13.3 (12.8–13.9)

All percentages reported are column percentages.

Abbreviations: CI, confidence interval; ED, emergency department; HCV, hepatitis C virus; NA, not applicable.

[a] Data from the National Ambulatory Medical Care Survey and the National Hospital Ambulatory Care Survey for Outpatient Departments.

[b] Data from the National Hospital Ambulatory Medical Care Survey for Emergency Departments.

[c] Data from the Nationwide Inpatient Sample.

[d] Includes adults aged ≥18 years.

[e] Fewer than 30 raw observations. The National Center for Health Statistics considers estimates based on <30 raw observations to be unreliable.

Table 2. Characteristics of Baby Boomer Individuals (Born 1945–1965) With Hepatitis C Infection, 2001–2010

Variable	Percentage of Outpatient HCV Visits (95% CI)[a] Annual n = 1 659 199	Percentage of ED HCV Visits (95% CI)[b] Annual n = 48 791	Percentage of Inpatient HCV Discharges (95% CI)[c] Annual n = 336 070
Sex			
Male	69.9 (64.4–74.9)	62.1 (53.9–69.7)	66.1 (65.6–66.6)
Female	30.1 (25.1–35.6)	37.9 (30.3–46.1)	33.9 (33.4–34.4)
Race			
White	65.4 (57.6–72.4)	65.0 (56.0–73.1)	57.0 (55.0–59.0)
Black	29.5 (22.3–37.9)	30.8 (23.0–39.9)	25.6 (24.0–27.3)
Other	5.1 (2.8–9.1)	4.2 (NA)[d]	17.4 (15.9–18.9)[e]
Ethnicity			
Hispanic	16.6 (11.3–23.7)[f]	19.4 (11.9–29.9)[f]	13.0 (11.7–14.5)
Non-Hispanic	83.4 (76.3–88.7)[f]	80.6 (70.1–88.1)[f]	87.0 (85.5–88.3)
Region			
Northeast	19.4 (14.0–26.1)	27.0 (18.0–38.3)	24.9 (22.1–27.8)
Midwest	16.8 (10.3–26.4)	14.3 (NA)[d]	16.4 (14.7–18.3)
South	38.6 (29.1–49.2)	36.3 (24.6–50.0)	35.9 (32.9–38.9)
West	25.2 (15.8–37.6)	22.4 (14.5–33.1)	22.9 (20.8–25.1)
Population setting[g]			
MSA or urban	90.7 (84.9–94.4)	95.2 (87.1–98.3)	92.4 (91.6–93.2)
Non-MSA or rural	9.3 (5.6–15.1)	4.8 (NA)[d]	7.6 (6.8–8.4)
Payor type			
Medicare	13.0 (9.3–18.0)	11.2 (NA)[d]	26.5 (25.9–27.2)
Medicaid	25.9 (20.5–32.3)	42.1 (32.6–52.2)	35.1 (33.8–36.5)
Private insurance	47.5 (38.3–56.8)	25.5 (18.1–34.6)	21.7 (20.7–22.8)
Self-pay	6.4 (4.1–9.9)	16.2 (NA)[d]	9.7 (8.9–10.5)
Other	7.2 (4.1–12.3)	5.0 (NA)[d]	7.0 (6.0–8.0)
Broad insurance type			
Private	51.1 (41.9–60.3)	26.8 (19.0–36.4)	23.4 (22.3–24.5)
Public (Medicaid/Medicare)	41.9 (34.3–50.0)	56.1 (45.7–66.0)	66.3 (65.1–67.4)
Self-pay	6.9 (4.4–10.7)	17.1 (NA)[d]	10.4 (9.5–11.3)
Median household income for ZIP code (quartile)			
$1–$38 999	. . .	. . .	39.8 (37.8–41.8)[f]
$39 000–$47 999	. . .	. . .	25.7 (24.7–26.8)[f]
$48 000–$62 999	. . .	. . .	20.7 (19.7–21.6)[f]
≥$63 000	. . .	. . .	13.9 (12.8–15.0)[f]
Primary diagnosis (*ICD-9-CM* category)			
Infectious and parasitic diseases	58.3 (50.9–65.4)	14.1 (9.6–20.1)	9.1 (8.8–9.4)
Mental disorders	5.4 (2.7–10.6)	11.8 (7.4–18.4)	13.7 (12.7–14.7)
Respiratory system	2.6 (NA)[d]	6.6 (NA)[d]	8.2 (8.0–8.4)
Digestive system	3.8 (2.2–6.4)	11.1 (NA)[d]	20.0 (19.6–20.5)
Symptoms, signs, ill-defined conditions, and other	30.0 (24.3–36.4)	56.4 (47.5–65.0)	49.0 (48.3–49.7)

Includes adults aged ≥18 years. Results stratified by care setting. All percentages reported are column percentages.

Abbreviations: CI, confidence interval; ED, emergency department; HCV, hepatitis C virus; *ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification*; MSA, Metropolitan Statistical Area; NA, not applicable.

[a] Data from the National Ambulatory Medical Care Survey and the National Hospital Ambulatory Care Survey for Outpatient Departments.

[b] Data from the National Hospital Ambulatory Medical Care Survey for Emergency Departments.

[c] Data from the Nationwide Inpatient Sample.

[d] Estimates based on <30 raw observations. The National Center for Health Statistics considers estimates based on <30 raw observations to be unreliable.

[e] Includes individuals identified as Hispanic.

[f] Data available for 2003–2010 only.

[g] MSA designation available only for outpatient and ED data, Inpatient discharge data uses urban and rural classification.

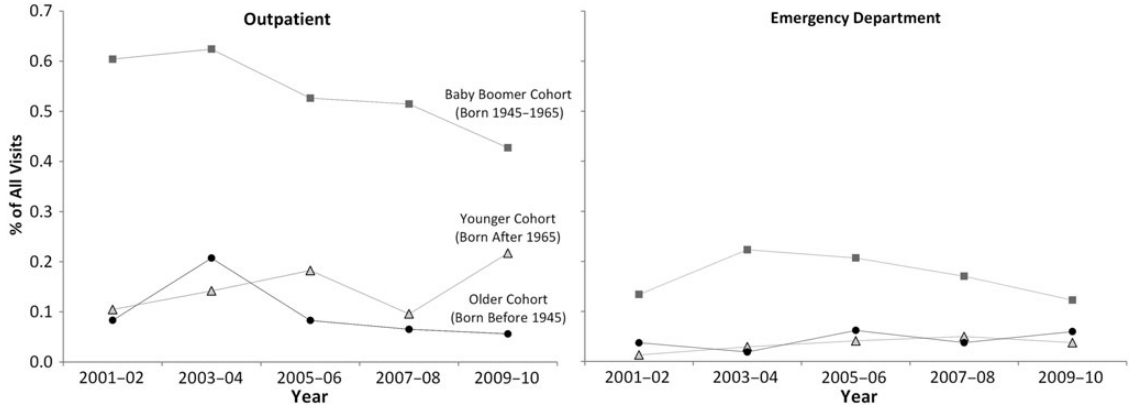

Figure 1. Trends in hepatitis C outpatient and emergency department visits by age cohort, 2001–2010. Outpatient data from the National Ambulatory Medical Care Survey (NAMCS) and National Hospital Ambulatory Medical Care Survey-Outpatient Department (NHAMCS-OPD). Emergency department data from NHAMCS-ED. 95% confidence interval estimates unavailable due to small numbers in some 2-year intervals. There was no significant change in the HCV rate for outpatient and emergency department visits in any age group.

in the lowest median household income quartile (39.8% vs 29.9%; $P < .001$) (Table 2). The proportion of discharges among patients with a liver-related complication was smallest for the younger cohort (13.6%; 95% CI, 12.8%–14.3%) and elevated for the others, with 34.5% (95% CI, 33.7%–35.3%) of the baby boomers and 40.5% (95% CI, 39.5%–41.4%) of the older cohort having a complication.

For the younger cohort, median charges differed between non-HCV discharges ($12 559; IQR, $7777–$21 973) and HCV-related discharges ($15 832; IQR, $8763–$31 394). For the baby boomer cohort, median charges were similar between discharges involving non-HCV ($21 540; $11 696–$41 509) and HCV ($22 364; IQR, $11 920–$44 619). The greatest difference in median charge was observed for the older cohort, with non-HCV ($23 484; IQR, $12 627–$45 053) substantially lower than HCV ($28 873; IQR, $15 385–$56 315). There were modest increases in median inpatient charge for discharges among the HCV-infected baby boomer and older cohorts (Figure 3). However, these increases were smaller than those observed for non-HCV discharges.

Diagnosis Subgroup Analysis

Between 2001 and 2010, there were large increases in the percentage of all discharges among the baby boomer cohort with HCV and a liver-related complication (Figure 2*B*; trend $P < .001$) and HCV with no liver-related complication (Figure 2*C*; trend $P < .001$). The percentage of liver-related complications among HCV discharges increased for the baby boomer and younger cohorts, but decreased for the older cohort (Figure 2*D*). The percentage of discharges among non-HCV-infected patients having a liver-related complication increased from 2001 to 2010 for all age groups (Figure 2*E*).

Among all adult inpatient discharges, charges and length of stay were greatest for patients with a liver-related complication, regardless of HCV status (Table 3). Annual inpatient charges among HCV-infected persons with a liver-related complication totaled $463 million for the younger cohort, $5.8 billion for the baby boomer cohort, and $1.3 billion for the older cohort. Temporal trends in charges did not vary substantially by diagnosis group (Supplementary Figure 1). Patients who were discharged with HCV and no liver-related complication were disproportionately black, underinsured, from the Northeast Census region, composed of residents from ZIP codes in the lowest quartile for household income, and admitted with a primary diagnosis of mental disorder (Table 3). We observed similar patterns for ambulatory medical care visits in the outpatient or ED setting (Supplementary Table 1).

DISCUSSION

This analysis provides current national perspectives of the burden of HCV infection on the US healthcare system. Individuals with HCV infection were large users of healthcare resources, incurring more than 2.3 million outpatient, 73 000 ED, and 475 000 inpatient hospital stays annually. Our findings highlight the challenges of and opportunities for improved care of individuals with HCV infection.

As expected, our study affirmed the disproportionate use of healthcare resources by the HCV-infected baby boomer cohort, accounting for approximately 1.7 million outpatient visits, 49 000 ED visits, and 336 000 inpatient discharges annually. However, there were other important observations that highlight the challenges of providing healthcare to this subset. For example, although the rates of outpatient and ED visits by the

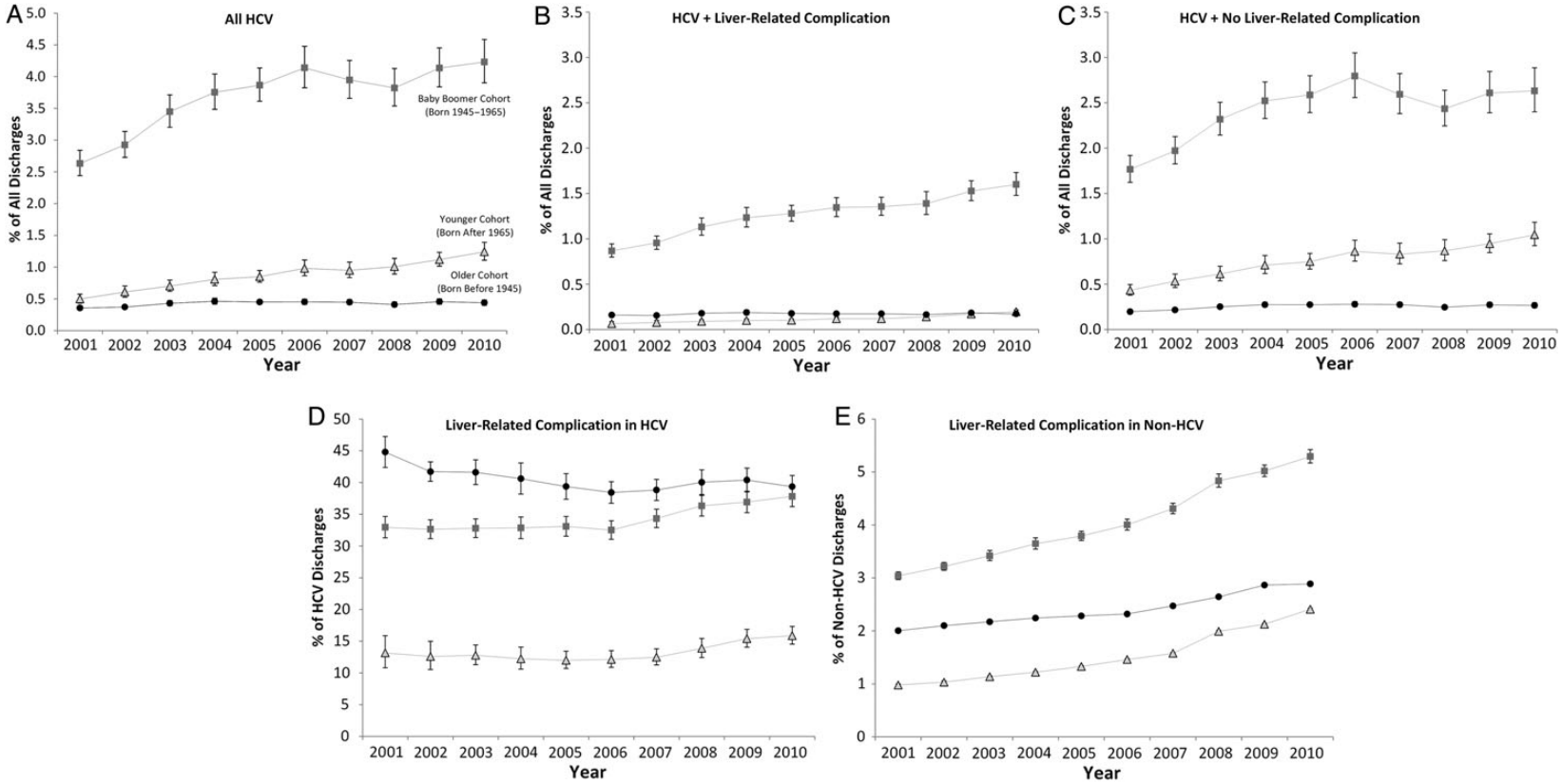

Figure 2. Inpatient discharge trends by age cohort and diagnosis group, 2001–2010. Data from the Nationwide Inpatient Sample. Error bars represent 95% confidence limits. Liver-related complication defined as chronic liver disease or cirrhosis, liver abscess and sequelae of chronic liver disease, other disorders of the liver, ascites, esophageal varices, hepatocellular carcinoma, or hepatorenal syndrome. Percentage change from 2001 to 2010 and test for linear trend. *A*, Younger, 149.1% ($P < .001$); baby boomer, 60.7% ($P < .001$); older, 23.1% ($P < .001$). *B*, Younger, 200.8% ($P < .001$); baby boomer, 84.4% ($P < .001$); older, 8.1% ($P = .215$). *C*, Younger, 141.3% ($P < .001$); baby boomer, 49.0% ($P < .001$); older, 35.3% ($P < .001$). *D*, Younger, 20.8% ($P < .001$); baby boomer, 14.8% ($P < .001$); older, –12.2% ($P < .001$). *E*, Younger, 146.2% ($P < .001$); baby boomer, 74.2% ($P < .001$); older, 44.1% ($P < .001$). Abbreviation: HCV, hepatitis C virus.

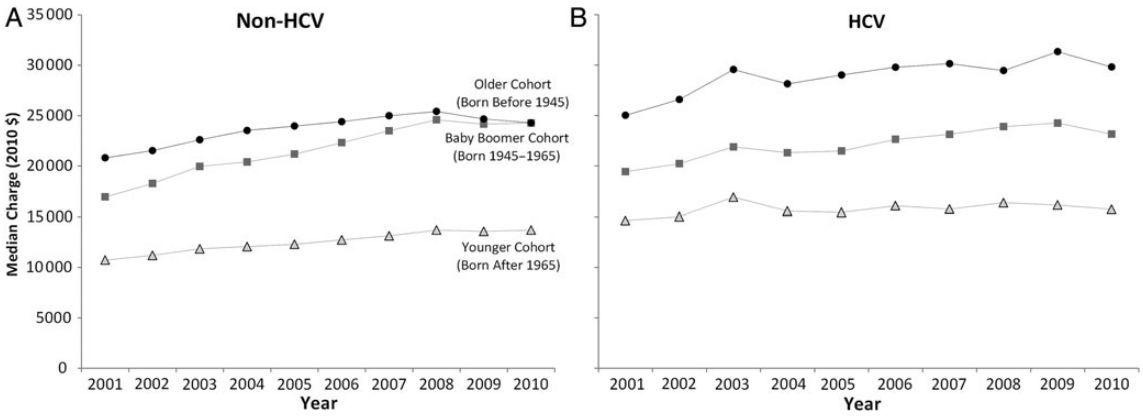

Figure 3. Trends in inpatient charges by age cohort and hepatitis C virus status, 2001–2010. Data from the Nationwide Inpatient Sample. Inpatient charges inflation-adjusted to 2010 dollars using the Consumer Price Index for inpatient services. Median charge calculated with appropriate survey design weights applied. Percentage change in median charge from 2001 to 2010: *A*, Younger, 27.6%; baby boomer, 43.3%; older, 16.7%. *B*, Younger, 7.3%; baby boomer, 19.2%; older, 19.2%. Abbreviation: HCV, hepatitis C virus.

HCV-infected baby boomer cohort remained stable from 2001 to 2010, the corresponding rates of inpatient discharge increased by >60%. Compared with outpatient and ED settings, a larger percentage of discharges involved a liver-related complication. Among the baby boomer cohort, discharges involving a liver complication were a substantial economic burden, totaling nearly $6 billion annually. At the current rate, in 10 years, HCV baby boomers may account for up to 912 000 annual hospitalizations, with acuity likely to increase given the underlying progressive liver disease and high comorbidity burden among these patients [17].

The increase in inpatient discharges relative to outpatient visits is also potentially worrisome. Although not indicated by our data, these findings may signal the inability of these individuals to access outpatient care and treatment to prevent the progression of HCV-related liver disease. These observations could also represent the results of delayed HCV detection, with individuals not presenting for care until after developing symptomatic end-stage liver disease or other severe sequelae. We also identified a very low percentage of HCV-related visits in rural settings; while potentially suggesting regional disparities in HCV prevalence, these findings may also indicate a lack of suitable HCV care resources outside of metropolitan areas.

Striking differences were noted between discharges of HCV-infected inpatients with and without liver-related complications. HCV-infected inpatients who were discharged without a liver-related diagnosis were disproportionately black and underinsured, and with a primary *ICD-9* code diagnosis of mental disorder. From 2001 to 2010, this group revealed a significant and steady rise in the proportion to all hospital discharges for the younger and baby boomer cohorts. These findings highlight the burden of mental health disorders, which include substance abuse and psychiatric illnesses, within this HCV-infected population. This suggests that efforts to successfully link and treat this population might require significant resources to stabilize both drug and alcohol addiction and psychiatric illness.

Across all settings, compared with HCV-seronegative patients, HCV-infected individuals were predominantly Medicaid or Medicare beneficiaries. Furthermore, the percentage of individuals with private insurance in the baby boomer cohort was <50% for all settings. These findings underscore that the increasing burden of funding HCV care will fall upon public resources. Inadequate health insurance coverage and poor access to regular healthcare have been extensively described as barriers to HCV screening and treatment. Stepanova et al revealed that a high proportion of persons infected with HCV have no insurance (38%) or have publicly funded health insurance (28%) [18]. Uninsured HCV-positive individuals in the same study were more likely to use the hospital emergency room than any other type of healthcare. Efforts to reduce the impact of HCV must consider expansion of HCV screening and early treatment among the uninsured and medically underserved. Additionally, the explosion of new direct-acting antivirals (DAAs) for the treatment of HCV will be useless without access for this large underinsured and uninsured cohort [19].

Prior studies examining the HCV healthcare burden have limitations. Tsui et al examined the NAMCS and NHAMCS-OPD data from 1997 through 2005 and reported a high proportion of HCV-related outpatient visits by the baby boomer cohort and disproportionate growth among nonwhites and Medicaid recipients [8]. Moorman et al assessed the clinical impact of chronic HCV infection through a prospective cohort study from 4 participating health systems, confirming the prominence of this condition among baby boomers [9]. Grant

Table 3. Characteristics of Adult Inpatient Discharges by Diagnosis Group, 2001–2010

Variable	Non-HCV and Non-Liver-Related % (95% CI) Annual n = 30 948 144	Non-HCV and Liver-Related % (95% CI) Annual n = 840 329	HCV and Non-Liver-Related % (95% CI) Annual n = 323 332	HCV and Liver-Related % (95% CI) Annual n = 151 891
Median charge (2010 $) (IQR)	19 064 (10 383–37 560)	26 395 (14 164–52 045)	20 201 (10 747–40 784)	25 899 (13 865–51 187)
Mean length of stay, d (95% CI)	4.7 (4.7–4.8)	6.8 (6.7–6.9)	5.9 (5.8–6.0)	6.4 (6.3–6.5)
Mean age, y (95% CI)	57.0 (56.7–57.2)	57.8 (57.6–58.0)	49.2 (48.9–49.4)	53.6 (53.4–53.8)
Sex				
Male	38.6 (38.3–38.9)	51.6 (51.3–51.9)	60.2 (59.6–60.8)	66.5 (66.0–67.0)
Female	61.4 (61.1–61.7)	48.4 (48.1–48.7)	39.8 (39.2–40.4)	33.5 (33.0–34.0)
Race				
White	70.0 (68.7–71.3)	68.1 (66.6–69.5)	56.7 (54.6–58.8)	59.2 (57.4–61.1)
Black	13.7 (12.9–14.5)	12.1 (11.3–12.9)	26.9 (25.2–28.6)	15.9 (14.8–17.0)
Other[a]	16.3 (15.4–17.4)	19.9 (18.6–21.2)	16.4 (14.9–18.1)	24.9 (23.2–26.7)
Ethnicity				
Hispanic	10.6 (9.7–11.5)	13.5 (12.4–14.7)	11.6 (10.3–13.2)	18.8 (17.2–20.6)
Non-Hispanic	89.4 (88.5–90.3)	86.5 (85.3–87.6)	88.4 (86.8–89.7)	81.2 (79.4–82.8)
Region				
Northeast	20.1 (18.7–21.5)	18.5 (17.0–20.0)	27.7 (24.8–30.9)	20.8 (18.1–23.8)
Midwest	23.5 (22.3–24.8)	21.8 (20.5–23.2)	16.1 (14.4–18.0)	15.6 (13.9–17.4)
South	38.3 (36.6–40.1)	38.5 (36.6–40.4)	35.4 (32.2–38.8)	37.3 (34.5–40.1)
West	18.0 (16.9–19.3)	21.2 (19.7–22.7)	20.7 (18.8–22.9)	26.4 (24.0–28.9)
Population setting				
Urban	86.0 (85.1–86.8)	88.1 (87.2–88.9)	92.3 (91.4–93.1)	92.3 (91.5–93.1)
Rural	14.0 (13.2–14.9)	11.9 (11.1–12.8)	7.7 (6.9–8.6)	7.7 (6.9–8.5)
Payor type				
Medicare	46.2 (45.7–46.8)	44.0 (43.4–44.6)	29.9 (29.1–30.7)	33.2 (32.5–34.0)
Medicaid	14.7 (14.2–15.2)	15.7 (15.1–16.2)	34.7 (33.3–36.1)	31.3 (30.3–32.3)
Private insurance	31.0 (30.4–31.6)	28.9 (28.2–29.5)	18.0 (17.1–19.0)	21.0 (20.0–22.0)
Self-pay	5.0 (4.7–5.3)	7.7 (7.3–8.1)	10.7 (9.7–11.7)	8.5 (7.8–9.3)
Other	3.1 (2.9–3.4)	3.8 (3.5–4.2)	6.7 (5.8–7.8)	6.0 (5.1–7.0)
Broad insurance type				
Private	32.0 (31.4–32.6)	30.0 (29.3–30.7)	19.3 (18.4–20.4)	22.3 (21.3–23.4)
Public (Medicaid/Medicare)	62.9 (62.3–63.4)	62.0 (61.4–62.7)	69.2 (68.1–70.3)	68.6 (67.6–69.7)
Self-pay	5.2 (4.8–5.5)	8.0 (7.5–8.4)	11.5 (10.4–12.6)	9.1 (8.3–9.9)
Median household income for ZIP code (quartile)[b]				
$1–$38 999	28.6 (27.5–29.8)	29.0 (27.7–30.2)	40.7 (38.6–42.8)	36.4 (34.5–38.2)
$39 000–$47 999	26.3 (25.4–27.1)	26.0 (25.2–26.9)	25.1 (24.0–26.2)	26.2 (25.1–27.2)
$48 000–$62 999	23.6 (22.9–24.4)	23.8 (23.0–24.5)	20.1 (19.1–21.0)	22.0 (21.0–23.0)
≥$63 000	21.5 (20.1–22.9)	21.2 (19.8–22.7)	14.2 (13.1–15.3)	15.5 (14.3–16.8)
Primary diagnosis (*ICD-9-CM* category)				
Infectious and parasitic diseases	2.8 (2.8–2.8)	5.3 (5.3–5.4)	6.8 (6.5–7.1)	13.3 (12.9–13.7)
Mental disorders	5.1 (4.8–5.3)	5.5 (5.2–5.8)	19.1 (17.6–20.7)	4.8 (4.5–5.2)
Respiratory system	8.8 (8.7–8.9)	5.9 (5.9–6.0)	8.8 (8.6–9.0)	5.8 (5.6–5.9)
Digestive system	9.1 (9.0–9.2)	33.5 (33.2–33.8)	9.1 (8.8–9.4)	38.9 (38.3–39.5)
Symptoms, signs, ill-defined conditions, and other	74.2 (73.9–74.5)	49.8 (49.4–50.1)	56.2 (55.1–57.4)	37.2 (36.7–37.7)

Data from the Nationwide Inpatient Sample. Includes adults aged ≥18 years. All percentages reported are column percentages. Liver-related complication defined as chronic liver disease or cirrhosis, liver abscess and sequelae of chronic liver disease, other disorders of the liver, ascites, esophageal varices, hepatocellular carcinoma, or hepatorenal syndrome.

Abbreviations: CI, confidence interval; HCV, hepatitis C virus; *ICD-9-CM*, *International Classification of Diseases, Ninth Revision, Clinical Modification*; IQR, interquartile range.

[a] Includes individuals identified as Hispanic.

[b] Data available for 2003–2010 only.

et al also used national inpatient data to characterize healthcare resource utilization by HCV-infected individuals [13]. However, their study was limited to 1994–2001, whereas our study included 2001–2010 and reflects the most current estimates. We also included ED and outpatient encounters provided by NHAMCS. Our study extends upon these prior efforts, confirming increases in HCV-related healthcare burden among baby boomers. Most alarming is the increase in inpatient utilization, suggesting that the progression of HCV-related liver disease will create an increasing healthcare burden over the coming decades.

The findings of our study highlight the urgency of expanding HCV detection and initial care nationally. HCV screening is inexpensive and reliable, with evolving treatment strategies making HCV an imminently curable disease. Recent advances in HCV treatment with DAAs have transformed the care of this previously incurable disease [20–22]. Coordinated screening efforts are paramount to detect the disease at its earliest stages, maximizing opportunities for early treatment and prevention of major health sequelae [23–25]. Early detection and treatment are viable and essential strategies for reducing HCV mortality and healthcare burden. Given the known healthcare utilization disparities and those observed in our study, limiting HCV screening and treatment to traditional settings will fall short of current needs and increasing rates of HCV-related cirrhosis and hepatocellular carcinoma. Ongoing healthcare reform changes must expand opportunities for HCV screening and treatment to all persons, regardless of insurance status, to achieve success similar to that seen with HIV through the Ryan White Care Act.

We recognize the limitations of the current analysis. NAMCS, NHAMCS, and NIS are retrospective, probability-sampled data sets. Recent studies have questioned the validity of the ambulatory medical care surveys [26, 27]. However, the methodologies of NAMCS and NHAMCS are rigorous, and the data sets have been widely used in similar analyses for >15 years [28, 29]. NAMCS, NHAMCS, and NIS date sets only include visits to non–federally employed office-based practices and noninstitutional general and short-stay hospitals (excluding federal, military, and Veterans Affairs hospitals). Given these known limitations, the large HCV burden identified in this study likely underestimates the true US burden. Furthermore, because a significant percentage of HCV infections remains undiagnosed, our findings will underestimate the true burden of HCV infection in the United States. The current analysis provides the best data available regarding the national impact of HCV.

Whereas we were able to characterize collective outpatient, ED and inpatient utilization by HCV-infected individuals, we were not able to determine the care or outcomes of individual persons. NAMCS, NHAMCS, and NIS data represent visits and discharges, not unique individuals. Therefore, we could not control for or determine patterns of readmission. Because of the limited number of diagnoses collected by each data set, we may have underdetected the number of healthcare encounters, particularly in the outpatient and ED settings. Our study describes the number of healthcare visits by HCV-infected individuals, but does not indicate the prevalence of the disease in the US population. Furthermore, we did not analyze comorbid diseases that may have led to increased healthcare visits by HCV-infected individuals.

In conclusion, individuals with HCV infection were large users of outpatient, ED, and inpatient health services in the United States, with resource use highest and increasing in the baby boomer cohort. These observations illuminate the public health burden of HCV infection in the United States.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online (http://cid.oxfordjournals.org). Supplementary materials consist of data provided by the author that are published to benefit the reader. The posted materials are not copyedited. The contents of all supplementary data are the sole responsibility of the authors. Questions or messages regarding errors should be addressed to the author.

Notes

Author contributions. H. E. W. certifies that he had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the analysis.

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All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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