

Consequences of Hepatitis C Virus (HCV): Costs of a Baby Boomer Epidemic of Liver Disease

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EXECUTIVE SUMMARY

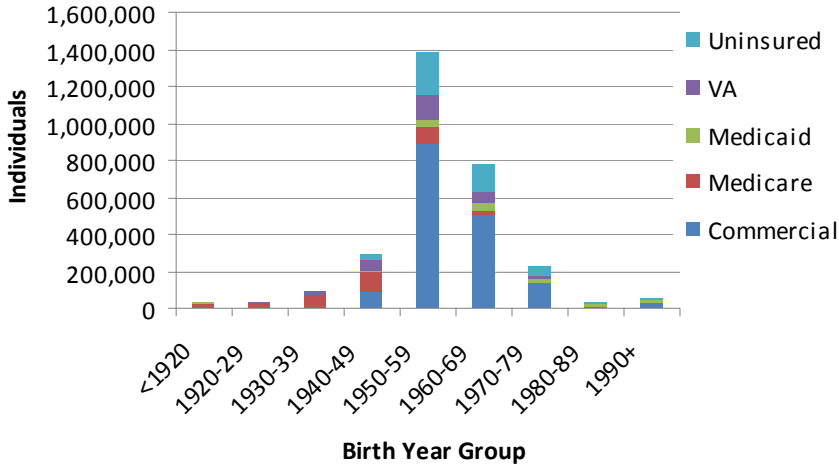
Baby boomers account for two out of every three cases of chronic hepatitis C virus (HCV) infection in the United States. As baby boomers infected with hepatitis C virus (HCV) age, their disease may progress from asymptomatic infection to advanced liver disease. This population and disease progression dynamic will result in large financial ramifications throughout our health care system. Receiving treatment for HCV infection prior to the onset of severe complications can reduce long-term, life-threatening consequences. However, we estimate that only approximately 22% of those infected with HCV are diagnosed. With current treatment side effects, long treatment duration, and limited efficacy associated with current antiviral therapies, even fewer patients receive treatment.

This report presents the projected direct medical cost impact of HCV infection on commercial and government payers over the next 20 years assuming no changes to current HCV infection management. The authors used recent U.S. payer datasets, population survey results, and disease progression information to project chronic HCV infection disease states and associated direct medical costs. Societal burdens other than direct medical costs of HCV disease are not considered in this study, but lost productivity and diminished quality of life associated with chronic HCV infection are likely substantial.

While new HCV infections have declined dramatically over the last two decades, at least 3 million Americans are chronically infected with HCV. Most of these individuals are baby boomers, the generation born between 1946 and 1964, and more than three out of every four (78%) are unaware of their infection. The long-term consequences of HCV infection, including cirrhosis, liver cancer, and liver failure can take decades to emerge, and the population of already infected individuals is entering a period of high cost burden as the sequelae of their infections appear.

Baby boomers account for two out of every three cases of chronic HCV infection in the United States.

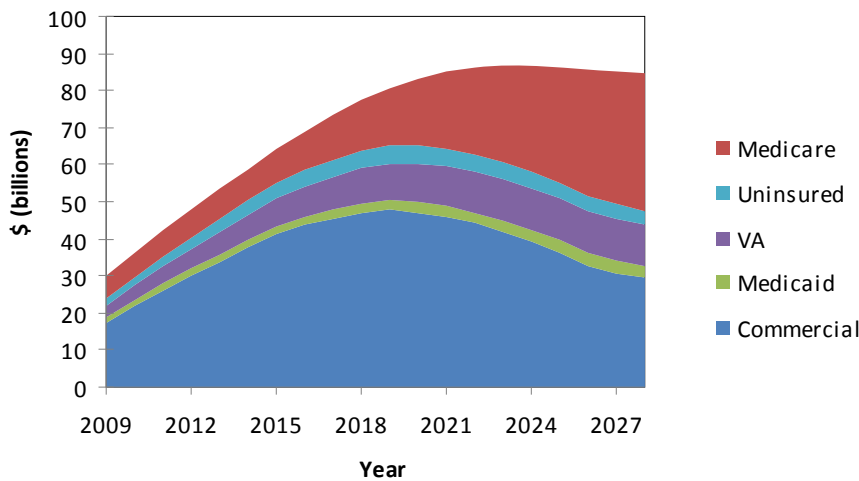
Estimated Numbers of Individuals with Chronic HCV Infection as of End of 2008 by Birth Decade and Source of Medical Insurance



The highest HCV infection prevalence rates are among Americans born in the early 1950s.

Baby boomers are, of course, aging. Because there are relatively few new cases of HCV infection, the average age of people with chronic HCV infection increases year by year. While the relative decline of new infections represents an important public health victory, we still face an escalation of health care expenditures generated by the population with chronic infection. As the disease progresses and baby boomers age, most payers will bear an increasing cost burden for patients with HCV infection.

Annual Medical Costs for People with Chronic HCV Infection from 2009 to 2028 by Source of Insurance



Total medical costs for patients with HCV infection are expected to more than double, from \$30 billion to over \$85 billion over the next 20 years.

The increase in mortality with age for baby boomers is magnified by the impact of HCV infection as the disease severity progresses over time, but we project costs of HCV-infected people to increase rapidly over the next decade despite the acceleration of mortality. The serious consequences of advanced liver disease we see today from chronic HCV infection give an early indication of the potential future disease burden. These include decompensated cirrhosis (the emergence of complications such as ascites, variceal bleeding, encephalopathy), hepatocellular carcinoma, and, for eligible patients, liver transplants. Without changes in how these patients are identified and managed, advanced liver disease will compose a rapidly growing portion of medical costs for HCV-infected patients over the next 5 to 10 years.

As the baby boomers age, the consequences of HCV infection will become an important cost issue for commercial payers and an even more important cost issue for Medicare. Over the next 20 years, total annual medical costs for patients with HCV infection are expected to more than double, from \$30 billion to over \$85 billion, and remain elevated. Medicare shows the most dramatic cost change, increasing fivefold from \$5 billion to \$30 billion.

In summary, without changes to the HCV diagnosis and treatment paradigm,

- Overall health care costs will more than double over 20 years
- The per-patient cost of people with chronic HCV infection will increase 3.5 times over 20 years
- In 10 years, commercial and Medicare costs will more than double
- In 20 years, Medicare costs will increase 5-fold.

This paper was commissioned by Vertex Pharmaceuticals Incorporated and reflects the research of the authors. It should not be considered an endorsement of any policy or product by Milliman, Inc. The authors would like to acknowledge the kind review provided by Gary L, Davis, MD. However, all errors and omissions are the authors' alone.

BACKGROUND

Chronic HCV Infection: An Epidemic Among Baby Boomers

Approximately 3 million Americans are currently infected with hepatitis C virus (HCV) and baby boomers – the generation born between 1946 and 1964 – account for two out of every three infected people. Medical claims data show that the prevalence of diagnosed HCV infection cases reaches a peak in people born in the early 1950s. More than three out of every four infected people are unaware that they are infected with HCV, because symptoms may be relatively mild until there is significant liver damage.

HCV is mostly transmitted through blood. With fewer than 20,000 new transmissions per year, new cases make up a very small portion of the total prevalence. The standard of care treatment for HCV infection is a regimen of pegylated interferon injections and ribavirin pills for multiple months. While current therapies for HCV can eradicate the virus, treatment success rates vary by a patient's virus type. Sustained virologic response (a measure of successful treatment) is achieved in only 40% of those with the most common type of HCV infection, genotype 1.

Receiving treatment for HCV infection prior to the onset of severe complications can reduce long-term, life-threatening consequences for patients who achieve sustained virologic response. Today, however, it is estimated that less than half of those infected with HCV are diagnosed. Given treatment side effects, long treatment duration, and limited efficacy associated with current therapies, fewer still receive treatment. Therefore, the infected population is decreasing only slowly and most patients remain chronically infected.

A number of epidemiological studies project striking increases over 25-30 years in complications related to chronic HCV infection as the disease progresses. Chronic HCV infection can progress to cirrhosis, liver cancer (hepatocellular carcinoma), and liver failure – collectively referred to as advanced liver disease. Treatments for advanced liver disease include procedures to drain ascites (the fluid that accumulates in the abdomen), medications, endoscopic intervention, or surgery to manage esophageal varices (dilated veins that can rupture and produce life-threatening hemorrhage), and liver transplantation. With an estimated 170 million cases worldwide, the management of HCV infection and its associated complications will be an increasingly important public health issue.

This report provides 20-year cost projections for the population infected with HCV in the U.S. in a form that, we hope, is accessible to payers and economic policy experts. We combined information from large U.S. payer datasets, population survey results, and disease progression studies. There are currently over 60 new therapies in clinical development for HCV

Baby boomers account for two out of every three cases of chronic HCV infection in the United States.

infection that may modify the current treatment protocol, but for the purposes of this report, the authors assume a treatment status quo – that there will be no advancements in the existing treatment paradigm. Our main focus is the medical cost impact of chronic HCV infection disease progression on commercial and government healthcare payers.

TODAY'S HCV-INFECTED POPULATION

Identifying Cases in U.S. Payer Data

We estimate that about 1.0% of Americans have chronic HCV infection. Most current estimates of the prevalence of HCV infection, including ours, are derived from National Health and Nutrition Examination Survey (NHANES), which has tested its sample of non-institutionalized Americans for HCV since the 1980s. We note that NHANES may underestimate prevalence, as it does not survey people who are incarcerated, homeless, living in nursing homes, or on active military duty, and some of these populations may have high prevalence rates. Our detailed methods are described further in Appendix I.

Based on our examination of medical claims data, we estimate that 78% of people with HCV infection have not been diagnosed. The medical claims results, even after multiple years of observation, show a much lower prevalence of diagnosed HCV infection than NHANES data suggest. Many people with HCV infection are currently asymptomatic, so the absence of coded diagnosis is not surprising.

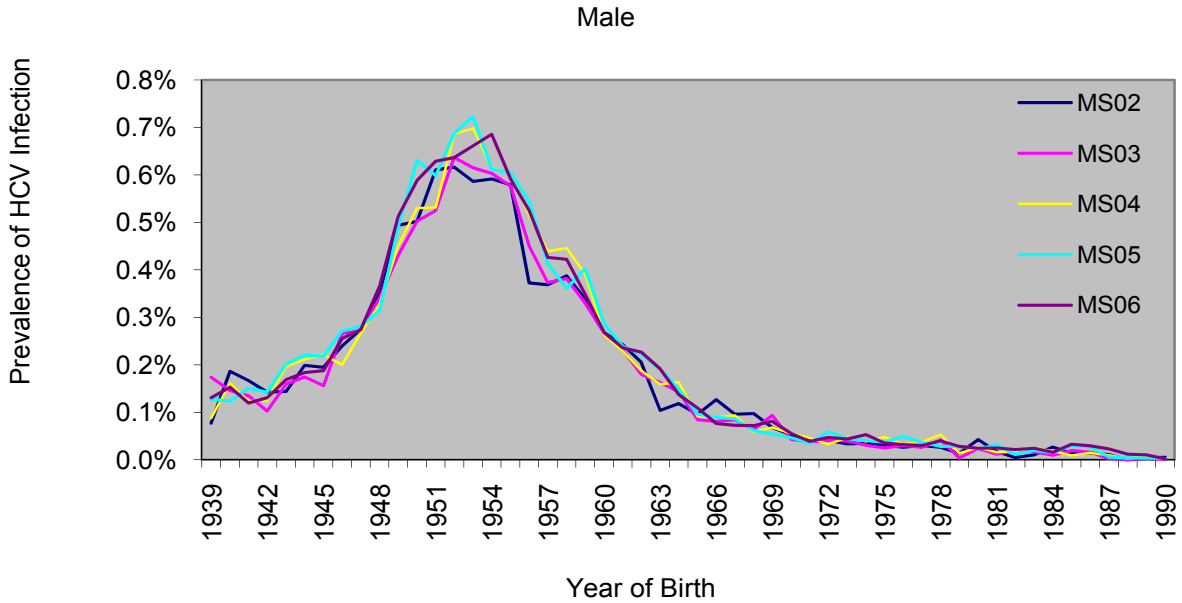
For the commercial population, we examined five annual installments of the Thompson MedStat MarketScan database to identify patients who are diagnosed with HCV. The results are consistent across the 5 years. The chart below shows the prevalence of diagnosed HCV in a commercial claims database by birth year for males. The different lines correspond to the diagnosed patients appearing in claims for medical services supplied in successive calendar year periods.

The peak birth year for both men and women is about 1953, with men having higher prevalence than women. Charts for commercial and Medicare female populations are in Appendix I.

We estimate that about 1% of Americans have chronic HCV infection.

Approximately 78% of people with chronic HCV infection have not been diagnosed.

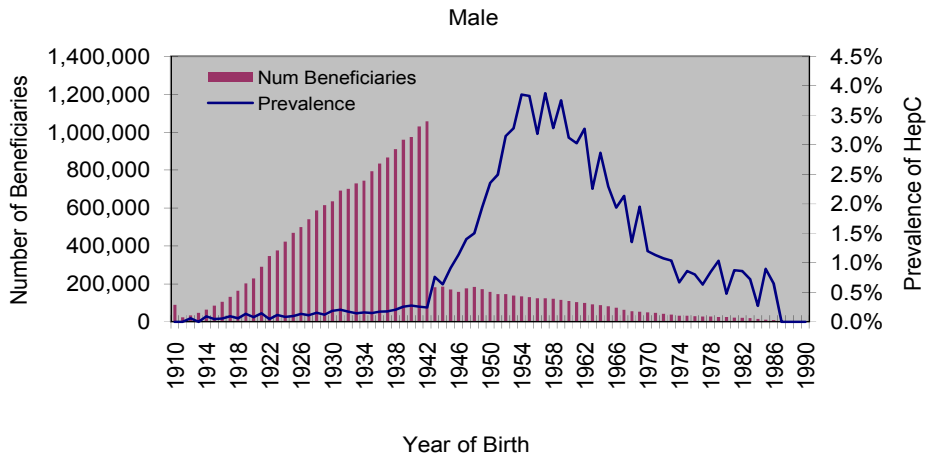
Prevalence of Diagnosed HCV Infection in Male Commercial Population by Year of Birth, 2002-2006



“MS02” refers to the source data – MedStat 2002. Each annual MedStat database contains the medical claims for millions of lives.

The chart below shows the Medicare fee-for-service enrollment by year of birth and the prevalence of diagnosed chronic HCV infection in male beneficiaries. The peak prevalence among these Medicare beneficiaries – men born in the early 1950s – is strikingly similar to that of commercially insured members. Infected members born around the peak years are among those qualifying for Medicare before age 65 because of disability or the End Stage Renal Disease Program. The peak of the U.S. HCV-infected population has not aged into Medicare eligibility; however, the chart below shows high prevalence of diagnosed HCV infection in baby boomers covered by Medicare.

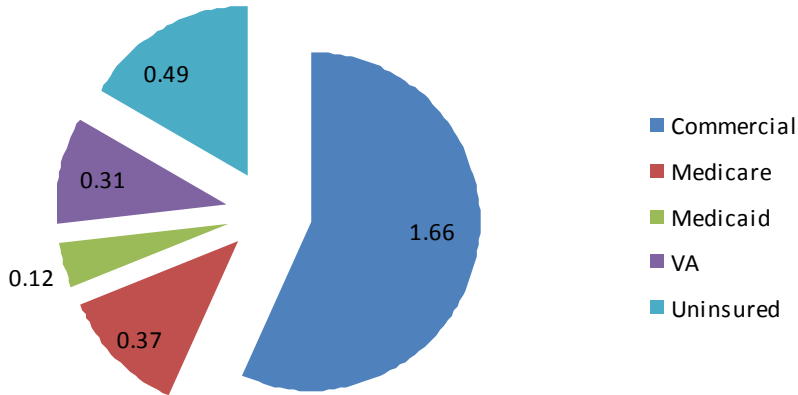
Number of Beneficiaries and Prevalence of Diagnosed HCV Infection in Medicare Males in 2006 by Year of Birth



Disabled baby boomers covered by Medicare have a high prevalence of diagnosed HCV infection.

Over half of HCV-infected patients are currently covered by commercial insurance. The uninsured and Medicare populations combined account for roughly 30% of HCV-infected patients. We note that HCV-infected people in correctional facilities are not captured in these estimates.

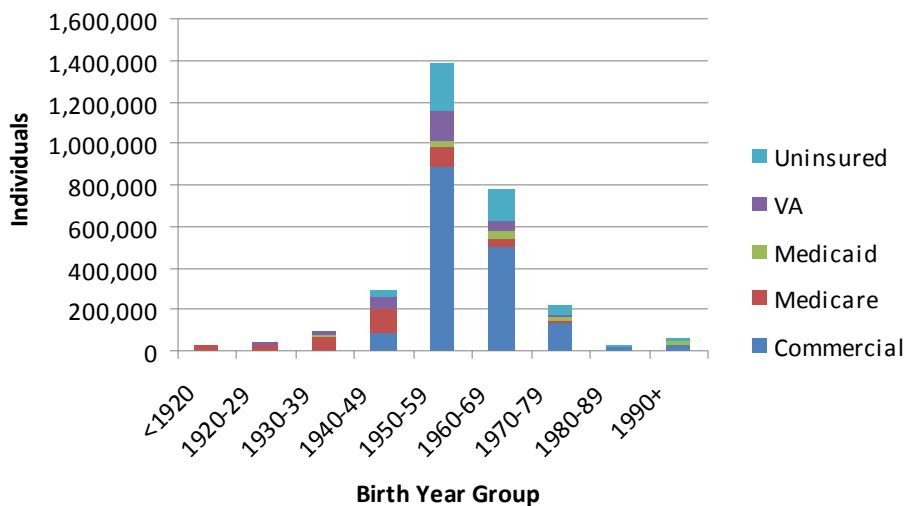
2008 Chronic HCV Infection Population by Source of Medical Insurance (in Millions): Total = 2.94 million



Over half of HCV-infected patients are now covered by commercial insurance.

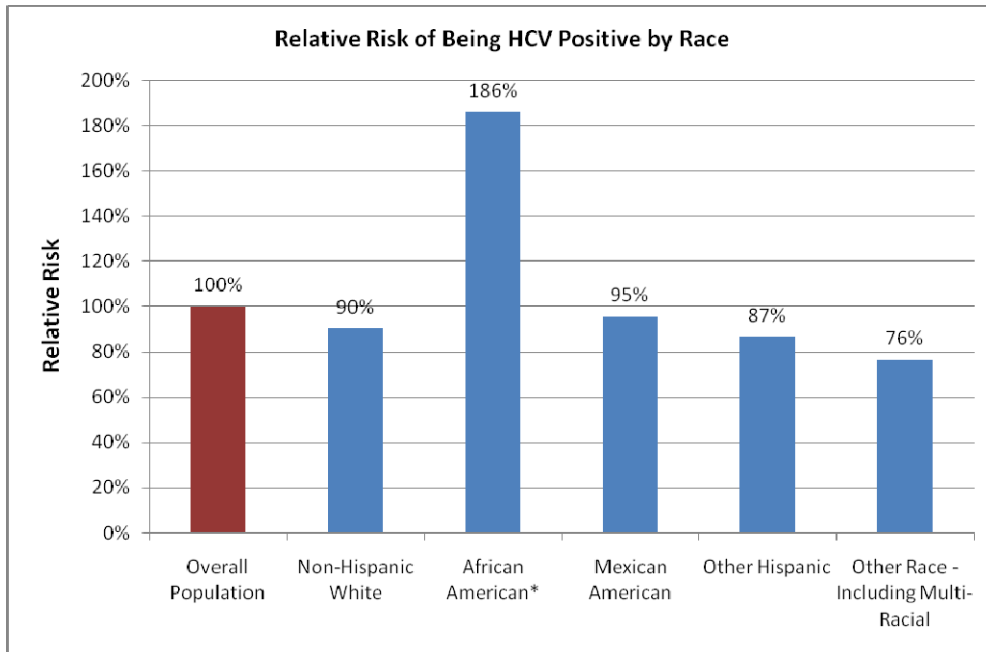
The chart below shows the number of individuals with chronic HCV infection, by decade of birth and source of medical insurance. Commercial insurance currently covers the majority of baby boomers (people born 1946-1964), with Medicare covering most people born before 1940. The highest HCV infection prevalence rates are among Americans born in the early 1950s. Medicare's share of HCV-infected people will increase as the baby boomer population ages into Medicare eligibility.

2008 Estimated Numbers of Individuals with Chronic HCV Infection by Birth Decade and Source of Medical Insurance



The highest HCV infection prevalence rates are among Americans born in the early 1950s.

The prevalence of chronic HCV infection varies by race, as shown in the following chart, which is based on several NHANES series. We developed the relative risk figures by dividing the actual NHANES number of HCV-positive individuals in each race group by the “expected” number (calculated by applying the average age-sex prevalence to the group’s population).



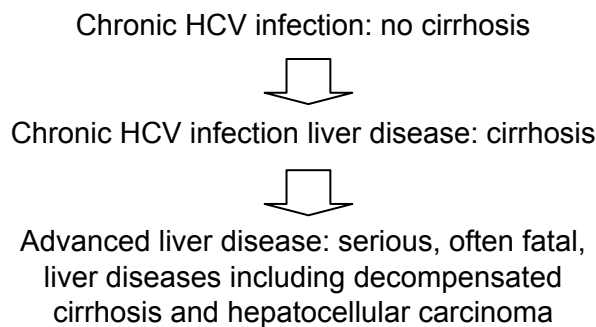
HCV prevalence is over-represented in African Americans.

*The African American category is named non-Hispanic black in NHANES.

The Stages of HCV-Related Liver Disease

While most people with HCV infection today have no symptoms, the disease can progress through stages of liver fibrosis and cirrhosis, to liver failure and hepatocellular carcinoma and death. Today, HCV-related liver disease is a leading reason for liver transplants.

In lay terms, an individual with HCV infection can progress through the following disease stages:



We modeled HCV-related disease progression from relatively asymptomatic disease through serious, often fatal consequences.

We modeled the HCV epidemic using disease progression stages that individuals pass through:

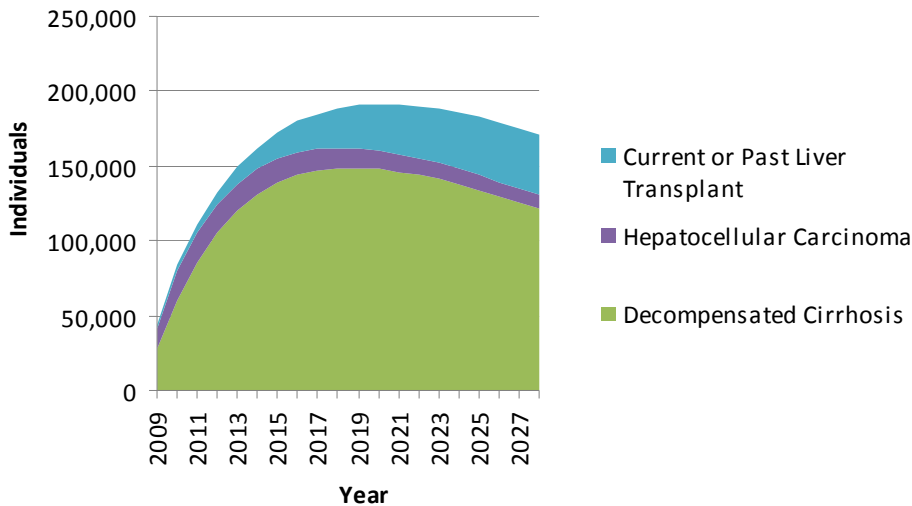
1. Chronic HCV infection without cirrhosis
2. Compensated cirrhosis
3. Decompensated cirrhosis (includes complications such as ascites, variceal bleed, encephalopathy)
4. Hepatocellular carcinoma (HCC or liver cancer, an indication for liver transplant in a limited number of patients)
5. Liver transplant (including new transplants and survivors of liver transplants in previous years)

FINDINGS

Advanced Liver Disease Forecast

Applying clinical and epidemiological data in our population model, we forecast that the total number of patients with advanced liver disease in 20 years will be more than four times greater than it is today. We assumed an annual mortality rate of 13% for decompensated cirrhosis and 86% for hepatocellular carcinoma. The mortality rate for liver transplant is 21% in the year following transplant and 5.7% for subsequent years. Methods are further described in Appendix I.

Advanced Liver Disease in Chronic HCV Infection Population from 2009 to 2028



The total number of patients with advanced liver disease in 20 years is projected to be more than four times greater than it is today.

Over the next 10 years, the number of patients with decompensated cirrhosis will more than quadruple, up from 30,000 to almost 150,000. The number of patients with hepatocellular carcinoma will triple from 5,000 to approximately 15,000. The dramatic increase to liver transplants in the above chart includes both new liver transplants to HCV patients and the survivors of liver transplants starting in 2009. The high mortality rates of these severe conditions mean that many people who have just been diagnosed with these conditions may live only a few years.

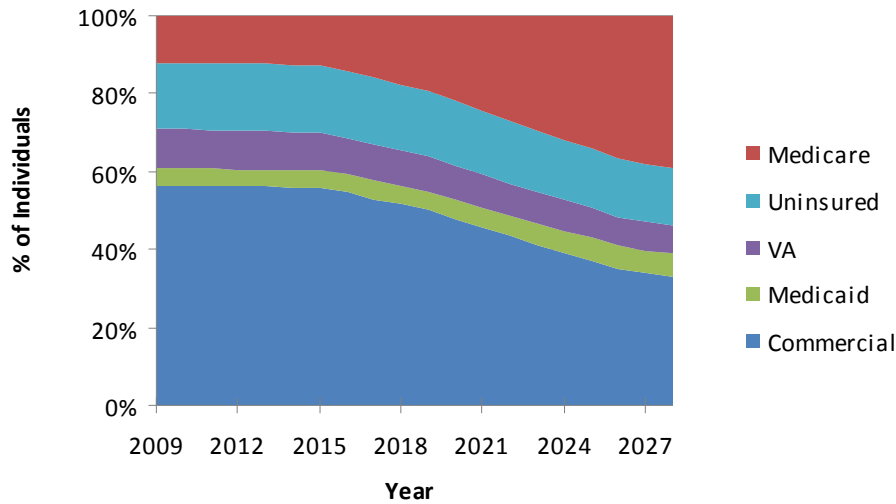
Over the next 5–10 years, the number of patients with decompensated cirrhosis will more than quadruple.

Payer Burden

Our population model follows individuals with chronic HCV infection, by payer, for 20 years using the assumptions described in Appendix 1. As baby

boomers age into eligibility, Medicare will bear responsibility for a growing portion of patients with chronic HCV infection – increasing from 12% in 2009 to 39% in 2028.

People with Chronic HCV Infection from 2009 to 2028 by Source of Medical Insurance



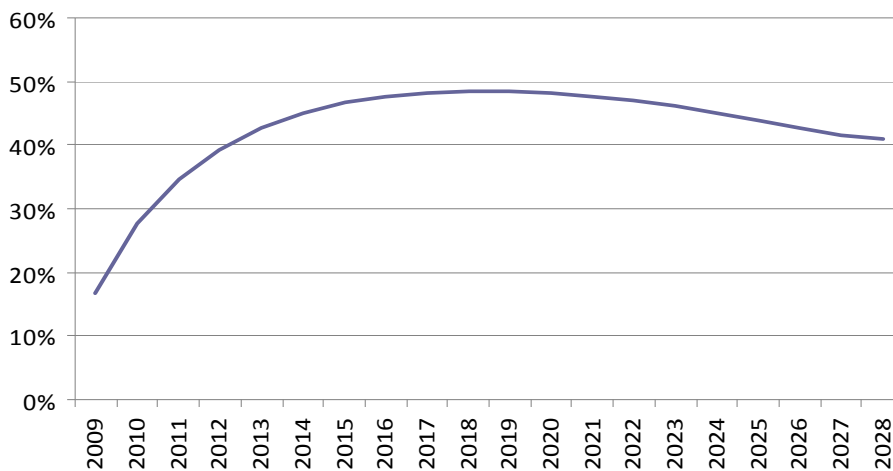
Medicare will bear responsibility for a growing portion of patients with chronic HCV infection – increasing from 12% to 39% in 2028.

Payer Costs Forecast

Medical costs of people with HCV infection vary greatly, but, on average, costs are much higher for patients with advanced liver disease. We examined medical claims databases to estimate the costs by disease stage.

The advanced liver disease that we are seeing today is likely just the beginning consequences of the baby boomer epidemic of chronic HCV infection. The chart below demonstrates that while less than a quarter of HCV-infected patients' medical costs are currently due to complications, progression of the disease will quickly change this dynamic dramatically. We expect these serious conditions will make up a rapidly growing portion of medical costs for HCV patients – increasing from under 20% to almost 50% – over the next 5 to 10 years.

Annual Percent of Medical Cost Due to Advanced Liver Disease* for People with Chronic HCV Infection 2009 to 2028



The portion of costs for people with chronic HCV infection due to advanced liver disease will increase from under 20% to almost 50% over the next 5 to 10 years.

*Decompensated cirrhosis, hepatocellular carcinoma, and liver transplants.

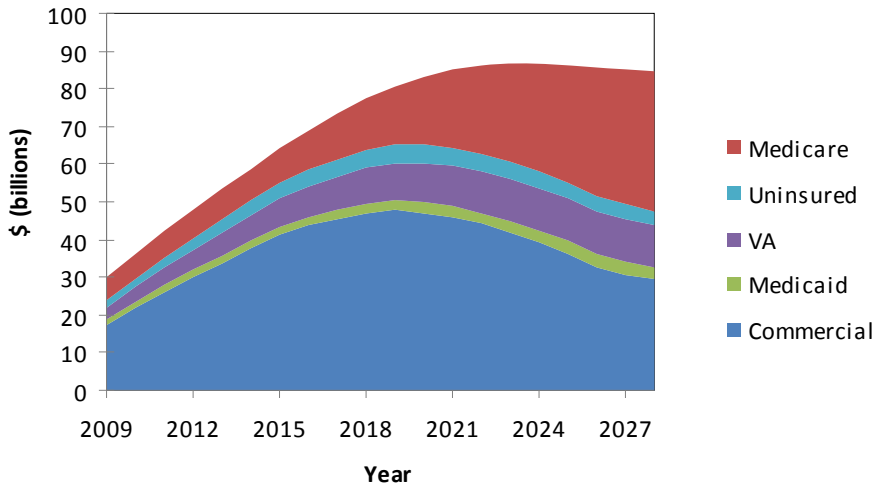
The preceding information, combined with our population, payer, and disease stage model, produces the following forecast by payer (see graph below).

Because of the interaction of disease progression, mortality, and Medicare eligibility ages, Medicare's portion of the cost of people with chronic HCV infection will initially decrease from about 21% in 2009 to about 14% in 2015 and then increase rapidly to 44% by 2028. Commercial payer costs will peak earlier in 2019.

Over the next 10 years, commercial and Medicare costs for people with chronic HCV infection will more than double.

Over the next 10 years, commercial and Medicare costs for people with chronic HCV infection will more than double. Over the next 20 years, total annual medical costs are expected to more than double, from \$30 billion to over \$85 billion, and remain elevated. Medicare costs alone show the most dramatic change, increasing fivefold from \$5 billion to \$30 billion.

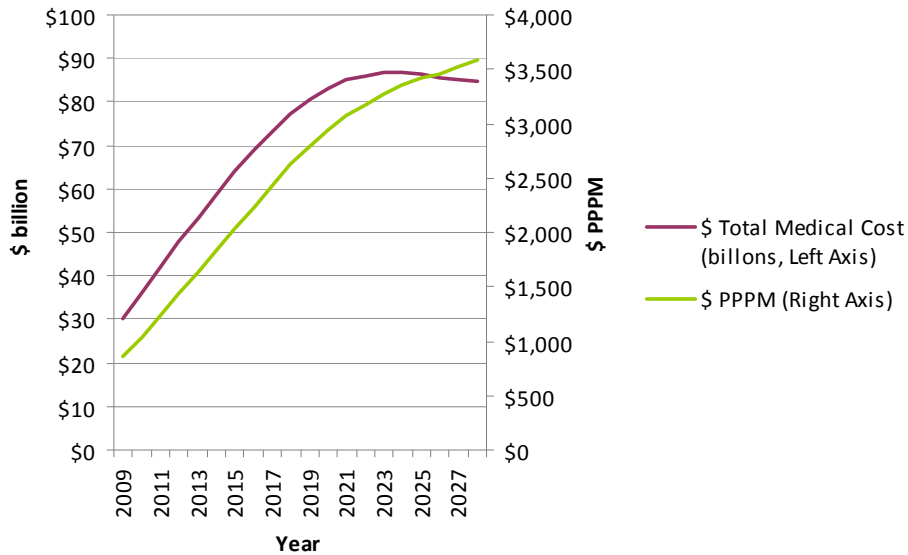
Total Annual Medical Costs for People with HCV Infection from 2009 to 2028 by Source of Medical Insurance



As the population ages and the disease progresses, government payers will bear the majority of the financial impact of chronic HCV infection.

The following graph shows that both total medical costs and per-patient-per-month (PPPM) costs increase rapidly for the next 10 years. PPPM costs continue to increase well past 10 years.

Chronic HCV Infection Population Annual Total Medical Costs and Per-Patient Per-Month Costs: 2009 to 2028



Per-patient costs for people with chronic HCV infection will increase rapidly as their disease progresses.

Conclusions

Our projections suggest that without improvements to the current low effective treatment rate, the U.S. healthcare system will be burdened with more HCV-infected patients progressing to cirrhosis, decompensated cirrhosis, and hepatocellular carcinoma, and ultimately, more patients requiring liver transplants. As more HCV infected people progress to advanced liver disease, we project these serious conditions to generate a rapidly growing portion of medical costs for HCV-infected people over the next 5 to 10 years, and lead to a dramatic increase in costs over the next 20 years. In the absence of improved and accessible treatments that can alter the progression of disease, payers, especially Medicare, will feel the impact of a baby boomers' advanced liver disease epidemic.

APPENDIX I: DETAILED METHODS

The results in this report are based on applying disease progression assumptions to payer-distinct populations of HCV infected people. We linked age and sex of the infected individual, costs, and mortality, to chronic HCV infection disease progression. We used a Monte Carlo simulation approach, applying transition probabilities on a monthly basis for 20 years.

We emphasize that most of the disease progression assumptions we used are based on limited data. We implicitly assumed that current treatment practices and cost levels would continue over the projection period.

The references for sources utilized in this study are detailed in Appendix II.

Populations and Demographics

Using the data sources listed, we estimated the demographics of the commercial, uninsured, Medicaid, Medicare, and Department of Veterans Affairs (VA) populations. As described below, prevalence rates were applied to these populations to estimate the number of people in each population with HCV infection.

The patients covered under any insurance program are in flux, and that is especially true for the Medicaid and uninsured populations. We did not model that dynamic, but assumed a balance – the HCV infection characteristics of people entering and leaving a payer category would be approximately equal. We did assume that both the Medicaid and uninsured populations would receive Medicare coverage based on age eligibility.

Prevalence of Chronic HCV Infection

- Total U.S. prevalence rates for positive hepatitis C antibody by year of birth and sex were determined by examining several series of National Health and Nutrition Examination Survey (NHANES).
- The prevalence of HCV infection among those served by the VA was found in literature reports on patients treated in VA facilities. We chose upper 95% CI of the prevalence range to be consistent with our choice of a low count for the “primary VA” population, which reflects the fact that the VA often provides some services to patients who also have other sources of coverage.
- The remaining, non-VA cases of HCV infection were allocated by population into Commercial, Medicare, Medicaid, and Uninsured by birth year and sex group according to NHANES prevalence by birth year and sex.

We estimate that about 1.0% of Americans are infected with HCV. Most current estimates of the prevalence of HCV are derived from NHANES, which has tested its sample of non-institutionalized Americans for HCV since the 1980s. We note that NHANES may underestimate prevalence, as it does not survey people who are incarcerated, homeless, living in nursing homes, or on active military duty, and some of these populations may have high prevalence rates.

Using the 4 datasets of NHANES, 1999-2000, 2001-2002, 2003-2004, and 2005-2006, the prevalence of HCV Antibody Positive in the entire population is reflected in the table below.

Prevalence of HCV Antibody Positive in Population

NHANES				Average of NHANES Results	Our Projection to 2008
1999-2000	2001-02	2003-04	2005-06		
1.2%	1.9%	1.5%	1.3%	1.5%	1.2%

Numerator: People with HCV antibody confirmed; Denominator: U.S. population.

Our projection to 2008 reflects the impact of growth and changes in U.S. population from the midpoint of the NHANES series (2002) to 2008.

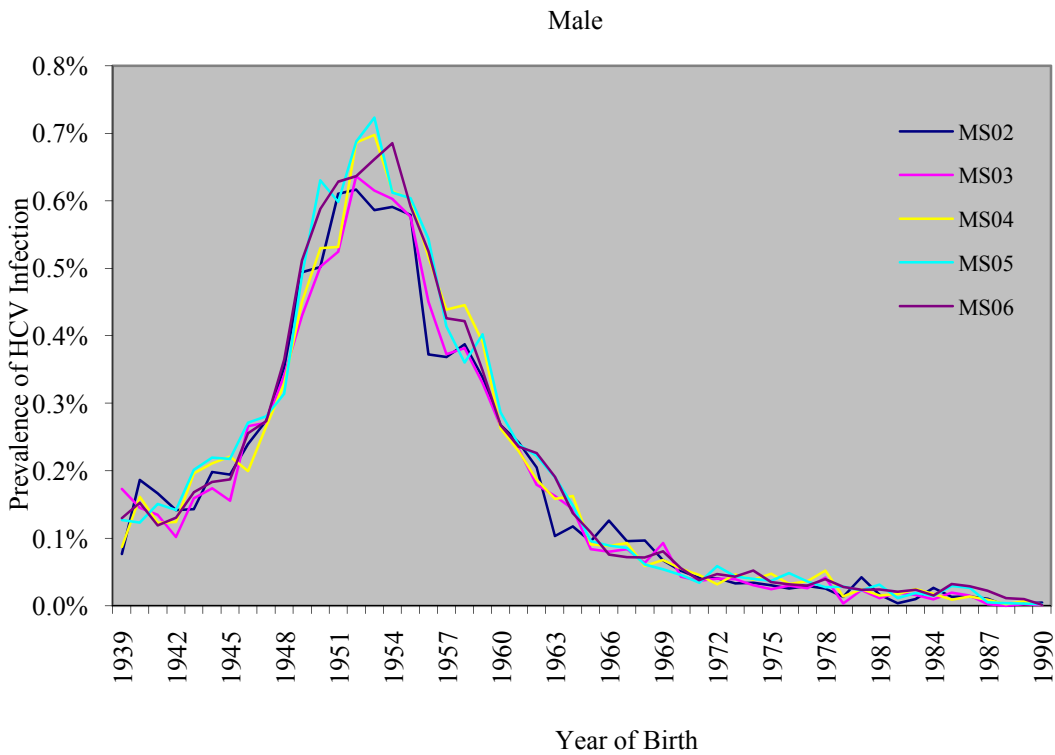
Some people infected with HCV spontaneously clear the virus, so a portion of people with HCV antibodies is not chronically infected. NHANES III 1988-1994 tested for both HCV antibodies and HCV RNA, the latter indicating chronic infection. Our analysis of these data suggests that about 78% of men and women with HCV antibodies are chronically infected with HCV. Applying 78% to the average of the four NHANES series, adjusted to the 2008 population age-sex distribution, gives our estimate of the U.S. population prevalence of chronic HCV infection of approximately 1.0%.

Based on our examination of multiple years of medical claims data, we estimate that about 78% of people with chronic HCV infection do not know they are infected. To arrive at this figure, we examined multiple series of annual, longitudinal medical claims data to identify individuals with diagnosed chronic HCV infection. We then projected to 10 years how diagnosed prevalence increases with years of observation. The multiple year approach is needed because patients are often not monitored routinely in early disease stages so may not be captured in claims, even over several years. Our modeling results show a much lower prevalence of diagnosed HCV than in the NHANES data, which reflects the lack of HCV diagnosis.

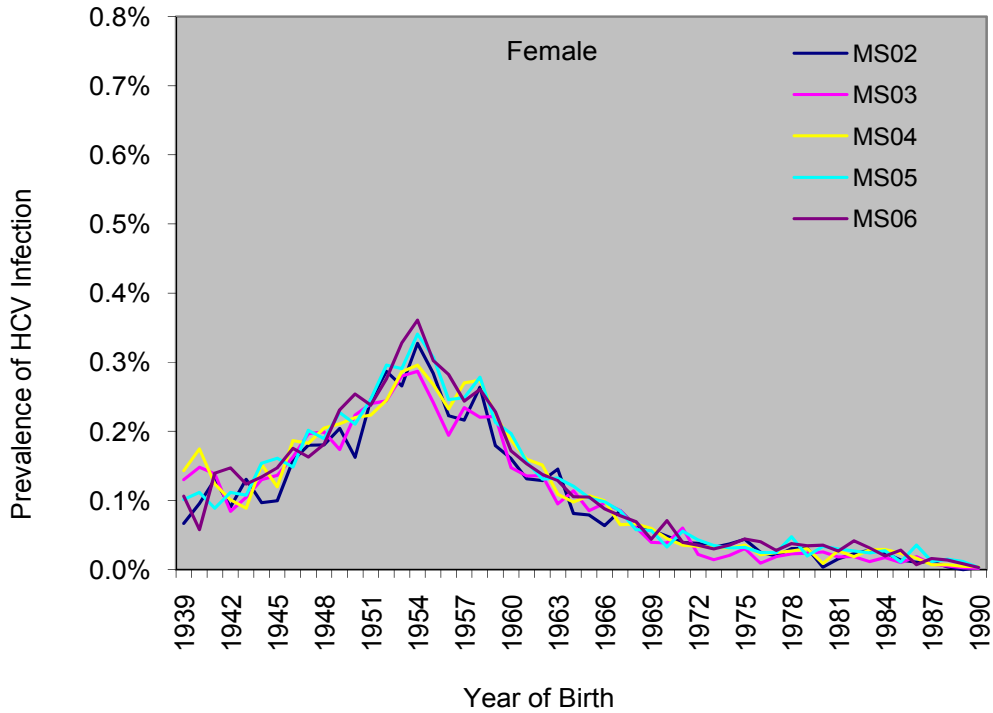
Because many people with chronic HCV infection are asymptomatic, the lack of diagnosis is not surprising.

The charts below show the prevalence of diagnosed HCV infection in a commercial claims database by the birth year of the individual. The different lines correspond to the diagnoses appearing in claims for medical services supplied in successive calendar year periods. The peak birth year for both men and women is about 1953, with men having both a sharper peak and higher prevalence than women.

Male Prevalence of Diagnosed Chronic HCV Infection in Commercial Population

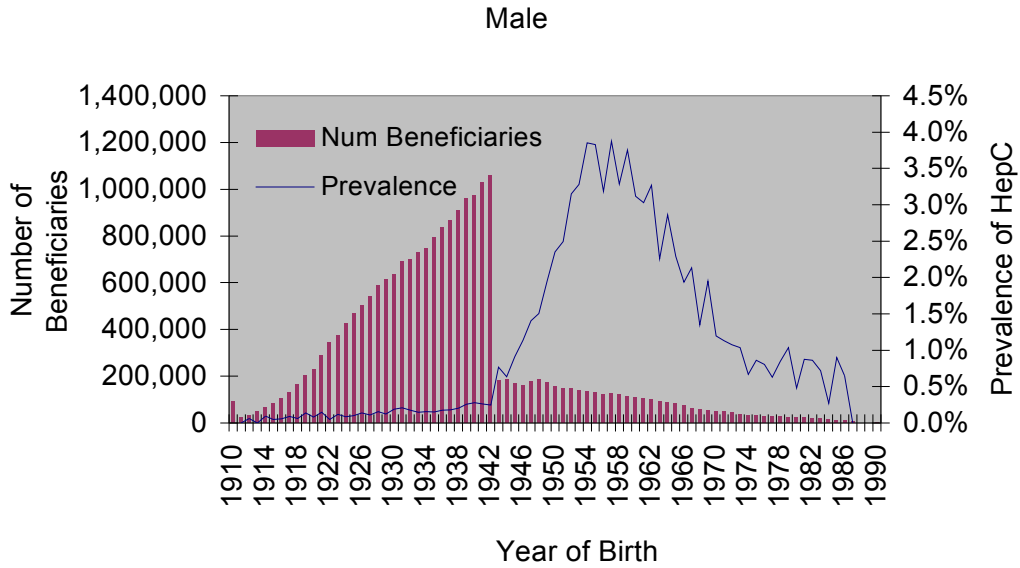


Female Prevalence of Diagnosed Chronic HCV Infection in Commercial Population

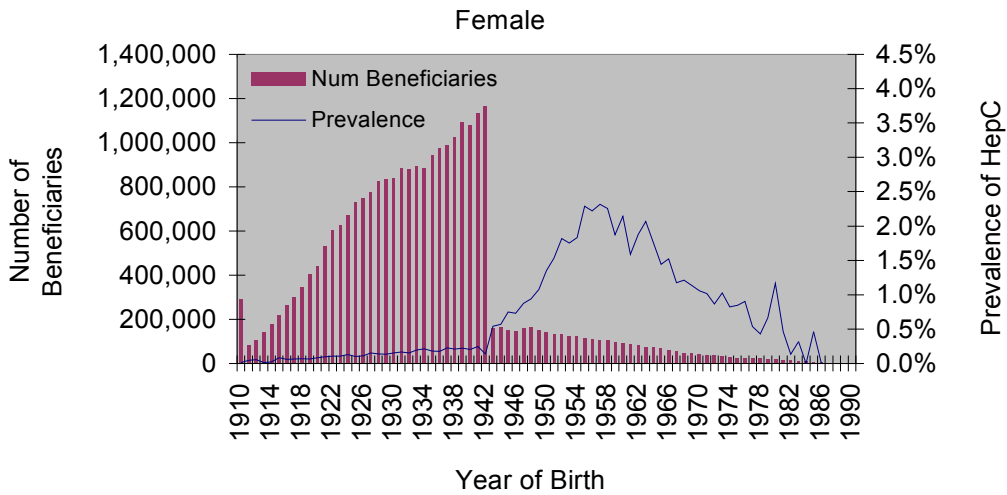


The Medicare population exhibits a similar pattern of diagnosed HCV infection. The charts below, for men and women, respectively, show both the Medicare fee-for-service enrollment by year of birth and the prevalence of diagnosed HCV among Medicare beneficiaries. In these charts, the peak prevalence is among beneficiaries born in the early 1950s, as it is for the commercial population. For Medicare, the peak occurs among beneficiaries who receive eligibility before age 65 through disability or the End Stage Renal Disease Program.

Number of Medicare Beneficiaries (denominator) and Prevalence of Diagnosed Chronic HCV Infection in Medicare 2006, by Age, Male



Number of Medicare Beneficiaries (denominator) and Prevalence of Diagnosed Chronic HCV Infection in Medicare 2006, by Age, Female



New Infections

- Each year, we added the equivalent of 19,000 newly infected patients to our cohorts. We assumed that all new cases would be among people born between 1980 and 1989. New cases were allocated to Commercial, Medicaid, and Uninsured according to the prevalence of HCV infection as of December 31, 2008 for people born between 1980 and 1989.

Medicare and Medicaid Benefit Transitions

- In our model, patients classified as Commercial, Uninsured, or Medicaid will be re-classified as Medicare upon attaining age-based Medicare eligibility.
- We assumed all dual eligibles are classified as Medicare beneficiaries to avoid double counting and because most of their acute care costs will be covered by Medicare.

Cost Assumptions by Payer

In this document, we consider cost as net payer cost after typical patient cost sharing, when applicable.

- Medicare and commercial costs were based on medical claims data from large longitudinal datasets identified in the Data Sources section.
- We assumed Medicaid and VA per-patient cost as 80% of Medicare cost.
- We did not include estimates for Medicare Part D drug costs.

A 2008 Kaiser Family Foundation study reports the ratio of uncompensated allowed costs for uninsured patients at 65%. We therefore assumed the compensated cost of uninsured patients is 35% of commercial cost, and that potential cost-shifting for uncompensated care to commercial patients is implicitly included in commercial costs or funded otherwise.

Cost of HCV

We used MedStat MarketScan and the Medicare 5% Sample databases to develop the costs of patients diagnosed with HCV at different stages in their disease. Additional cost assumptions were required to adjust for the 78% of HCV-infected individuals who are not diagnosed. We assumed HCV-infected people with the most severe manifestations of HCV would be diagnosed. Therefore, for chronic HCV infection without cirrhosis and for compensated cirrhosis, our cost estimates are based on the weighted

averages of the standard age-sex population costs and the costs of diagnosed individuals. The weights used take into account the estimated undiagnosed portions.

The table below shows the cost assumptions we used as inputs in our model. Overall, Medicare has lower reimbursement than commercial, which explains why Medicare costs for some conditions have lower PPPM costs.

Summary of Assumptions of Paid Cost Per Patient Per Month (PPPM)
as of 2008

Disease States		PPPM		
		Commercial	Medicare*	
			Age <65	Age 65+
Chronic HCV Infection (without Cirrhosis)		\$174 more than Avg	\$515 more than Avg	\$460 more than Avg
*Compensated Cirrhosis without Complication		\$370 more than Avg	\$772 more than Avg	\$611 more than Avg
Decompensated Cirrhosis (DC)	0-6 months from DC	\$13,900	\$7,100	\$7,100
	6+ months from DC	\$12,700	\$4,200	\$4,200
Hepatocellular Carcinoma (HCC)	0-6 months from HCC	\$5,500	\$2,400	\$2,400
	6+ months from HCC	\$4,900	\$2,100	\$2,100
Liver Transplant (LT)	0-6 months from LT	\$38,900	\$24,700	\$24,700
	6-18 mos from LT	\$5,600	\$3,800	\$3,800
	18+ mos from LT	\$3,900	\$2,200	\$2,200

*Medicare figures do not include estimates for the costs of Part D drugs.

Disease states are mutually exclusive.

The under-65 Medicare population consists largely of people who qualified for Medicare through disability or the End Stage Renal Disease Program. These under-65 Medicare beneficiaries tend to have higher costs, but the data suggest that under-65 and over-65 beneficiaries have similar costs if they have advanced HCV disease.

Disease Stage Prevalence and Transition Rate Assumptions Summary

Based on medical literature and our examination of claims data, we estimate that, among people with chronic HCV infection, about 23% are affected by advanced liver disease.

We applied the following transition rates in our model, which were based on the literature.

Transition	Annual Transition Rate
HCV Infection to Compensated Cirrhosis	0.6% 2.3%*
Compensated Cirrhosis to Decompensated Cirrhosis	4.0%
Compensated Cirrhosis to Hepatocellular Carcinoma	3.9%
Decompensated Cirrhosis to Liver Transplant	3.1%
Hepatocellular Carcinoma to Liver Transplant	4.3%

*0.6% if 1-13 years from HCV infection, 2.3% if 14+ years from HCV infection according to Ward 2004 and Wong 2000. The former study suggested after 20 years, 20% of individuals with chronic HCV develop cirrhosis. The later study suggested after a 13.7 year time lag, the annual probability of developing cirrhosis for those with moderate HCV is 7.3%.

We note the liver transplant rates assume a moderate increase in the supply of organs or that a greater portion of transplants will go to HCV patients. A significant change in organ supply or organ allocation could make these figures too small or too large.

Mortality Assumptions by Disease Stage

Disease State	Annual Mortality Rate
Chronic HCV infection (but not Cirrhosis)	Population
Compensated Cirrhosis (not including hepatocellular carcinoma)	Population
Decompensated Cirrhosis	13%
Hepatocellular Carcinoma	86%
Liver Transplant	21.0% 5.7%*

*21.0% 1st year post transplant, 5.7% thereafter.

Population mortality was obtained from the U.S. Census Bureau.

APPENDIX II: DATA SOURCES

Population and Cost Information

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Disease State Transition Rates Including Mortality Loads

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