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MAJOR ARTICLE

Implementation of a Large System-Wide Hepatitis C Virus Screening and Linkage to Care Program for Baby Boomers

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Background. We implemented and evaluated a large health system-wide hepatitis C virus (HCV) screening and linkage to care program for persons born between 1945 and 1965 ("baby boomers").

Methods. An electronic health record (EHR) clinical decision support (CDS) tool for HCV screening for baby boomers was introduced in August 2015 for patients seen in the outpatient University of California, Los Angeles healthcare system setting. An HCV care coordinator was introduced in January 2016 to facilitate linkage to HCV care. We compared HCV testing in the year prior (August 2014–July 2015) to the year after (August 2015–July 2016) implementation of the CDS tool. Among patients with reactive HCV antibody testing, we compared outcomes related to the care cascade including HCV ribonucleic acid (RNA) testing, HCV RNA positivity, and linkage to HCV specialty care.

Results. During the study period, 19 606 participants were screened for HCV antibody. Hepatitis C virus antibody screening increased 145% (from 5676 patients tested to 13 930 tested) after introduction of the CDS intervention. Screening increased across all demographic groups including age, sex, and race/ethnicity, with the greatest increases among those in the older age groups. The addition of an HCV care coordinator increased follow-up HCV RNA testing for HCV antibody positive patients from 83% to 95%. Ninety-four percent of HCV RNA positive patients were linked to care postimplementation.

Conclusions. Introduction of an EHR CDS tool and care coordination markedly increased the number of baby boomers screened for HCV, rates of follow-up HCV RNA testing, and linkage to specialty HCV care for patients with chronic HCV infection.

Keywords. baby boomers; care cascade; hepatitis C virus; linkage to care; screening.

The US Centers for Disease Control and Prevention and US Preventive Services Task Force (USPSTF) recommend a one-time hepatitis C virus (HCV) screening for adults born between 1945 and 1965 (a birth cohort known as "baby boomers") [1, 2]. Approximately three-quarters of persons chronically infected with HCV are baby boomers, many of whom are unaware of their infection [2, 3].

Efforts to increase case identification and increase linkage to care and treatment have had mixed results [4, 5]. The biggest gaps are in screening and linkage to care [5]. It is essential that those particular areas are optimized, to increase downstream treatment rates and improve HCV-related patient outcomes, reduce future healthcare costs, and limit HCV transmission [6].

We implemented an HCV screening and linkage to care initiative within the University of California, Los Angeles (UCLA) Health, a large complex health system with a broad catchment area, following recommendations from the USPSTF for one-time HCV screening in persons born between 1945 and 1965 [1]. Our aim in this analysis was to report on the implementation of the program and to evaluate its impact on HCV screening and linkage to care.

METHODS

The Health System and Introduction of a Hepatitis C Virus Screening Reminder

UCLA Health consists of approximately 60 outpatient primary care practices throughout Southern California serving approximately 180 000 patients, and it uses an Epic-based electronic health record (EHR) system (Epic Systems Corporation, Verona, WI). We first obtained approval from key stakeholders including hospital leadership, primary care group directors, the information technology unit, and the clinical laboratory. After those administrative approvals, in August 2015 HCV screening status was added to the routine health maintenance reminder, a clinical decision support (CDS) tool in the EHR, for patients born between 1945 and 1965. Within the health maintenance reminder, HCV screening was noted as "due" among patients with no laboratory evidence of HCV testing (HCV antibody or HCV ribonucleic acid [RNA]) in their EHR or if testing was not marked as "completed" by the provider. The CDS tool was available in all charts, but it only appeared on the patient's dashboard if previously activated by the provider.

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Patient Care Coordination

A full-time, nonclinically trained, dedicated HCV care coordinator was introduced in January 2016 in the UCLA Health hepatology unit to facilitate follow up and linkage to care for HCV positive patients. The UCLA microbiology laboratory pulled HCV antibody results from the ADVIA Centaur XP System (Siemens Medical Solutions USA, Inc., Malven, PA), and, through a secure intrahealth system, sent a daily list of all HCV antibody reactive patients to the HCV care coordinator by e-mail. The care coordinator used an internal electronic message to contact outpatient providers to recommend the following: (1) quantitative HCV RNA testing with reflex to HCV genotype testing and (2) noninvasive serum fibrosis testing by PROMETHEUS FIBROSpect II (PROMETHEUS Therapeutics and Diagnostics, San Diego, CA). The care coordinator did not order tests at any time. The provider informed patients of test results via telephone, the EHR patient portal, mailed letters, or at the patient's next visit. After informing the patient, the provider contacted the care coordinator to facilitate linkage to care through a referral to hepatology or infectious diseases for patients with detectable HCV RNA. A flowchart depicting the HCV care coordination pathway is presented in Figure 1. The HCV care coordinator then telephoned the patient to help schedule follow-up visits. Patients indicating they did not wish to be linked to care during the initial call were given the care coordinator's direct contact number for future follow up.

Data Collection

Data were abstracted from the EHR for 2 periods: August 1, 2014 through July 31, 2015 (preimplementation of the HCV screening intervention) and August 1, 2015 through July 31, 2016 (postimplementation). Patients were eligible for inclusion if they (1) were born between January 1, 1945 and December 31, 1965, (2) had a primary care visit between August 1, 2014 and July 31, 2016, (3) were seen at one of the outpatient clinics within UCLA Health, and (4) were tested for HCV during their visit. Patients without previous documentation of positive HCV antibody or HCV RNA testing within the EHR or a diagnosis in their medical record, as determined by electronic chart review, were included in the analysis. Data abstraction included age, sex, race/ethnicity, as well as HCV testing related data, including HCV RNA testing and linkage to care. Linkage to care was defined as whether a patient attended an initial appointment with an infectious diseases or hepatology specialist within 6 months of receiving the HCV antibody positive results as documented in the EHR. The UCLA Institutional Review Board approved the study before data collection.

Data Analysis

Summary statistics for demographic and clinical characteristics of HCV tested patients overall and by study period (pre- and postimplementation) were calculated. The χ^2 tests were used to compare patient characteristics between the pre- and postimplementation period and between screened and unscreened patients. Number of HCV antibody tests, HCV antibody positivity rate among those tested, and rate of HCV RNA testing for HCV antibody positive patients were assessed for the overall cohort and by age, sex, and race/ethnicity. Differences in rates of HCV antibody positivity by these demographics were evaluated using χ^2 tests. The change in the number of HCV antibody tests and rates of HCV antibody positivity over the period from preimplementation to postimplementation were assessed using different techniques of time series analysis including a Cochran-Armitage test for trend, a modified Mann-Kendall test, and a segmented regression analysis of interrupted time series [7]. The interrupted time series analysis allowed us to examine the intervention effect while taking into account time trends as well as any autocorrelations among the observations. The outcomes of interest (HCV testing and antibody positivity) were divided into 12 monthly data points before implementation of the intervention compared with the 12 monthly data points postimplementation. To evaluate the effectiveness of the HCV care coordinator, data were also analyzed comparing 2 periods: January 1, 2015–July 31, 2015 (pre-HCV care coordinator) and January 1, 2016–July 31, 2016 (post-HCV care coordinator), resulting in 87 antibody positives with a record available for review during the pre-HCV care coordinator period and 131 antibody positives during the post-HCV care coordinator period. All analyses were conducted using SAS version 9.4 (SAS Inc., Cary, NC).

RESULTS

A total of 19 606 patients were tested over the 2-year program evaluation period, with a greater proportion of women compared with men (54% vs 46%) and whites representing the single largest race/ethnic group (65%), followed by Hispanics/Latinos (12%) (Table 1). The number of those newly tested each month

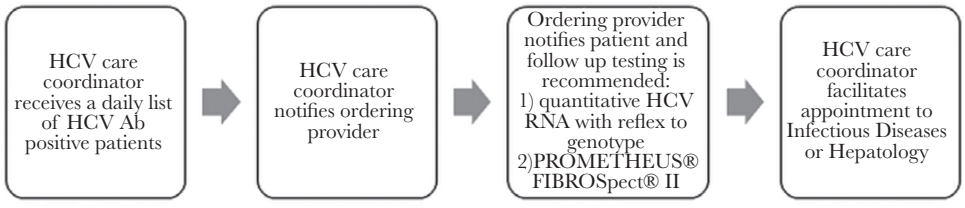

Figure 1. Hepatitis C virus (HCV) linkage to care process. Ab, antibody; RNA, ribonucleic acid.

Table 1. HCV Testing Before and After Implementation of an HCV Screening Program Among "Baby Boomers", UCLA Health System, August 2014–July 2016

Patient Characteristics	Total (n = 19606)		August 2014–July 2015 (n = 5676)[a]		August 2015–July 2016 (n = 13930)[a]		%Increase in HCV Testing	P Value
	n	%	n	%	n	%		
Age, years								<.01
49–54	5549	28.3	1854	32.7	3695	26.5	99.3	
55–59	5069	25.9	1529	26.9	3540	25.4	131.5	
60–64	4634	23.7	1219	21.5	3415	24.5	180.1	
65–71	4354	22.2	1074	18.9	3280	23.6	205.4	
Sex								<.01
Female	10637	54.2	3192	56.2	7445	53.5	133.2	
Male	8969	45.8	2484	43.8	6485	46.5	161.1	
Race/Ethnicity								<.01
Asian	1654	9.6	515	10.0	1139	9.4	121.2	
Black or African American	1172	6.8	419	8.1	753	6.2	79.7	
Hispanic or Latino	2033	11.8	687	13.4	1346	11.1	95.9	
Other	1230	7.1	353	6.9	877	7.3	148.4	
White	11144	64.6	3169	61.6	7975	66.0	151.7	

Abbreviations: HCV, hepatitis C virus; UCLA, University of California, Los Angeles.

[a]Sum may not equal to total due to missing data

increased from 519 patients per month in August 2014 to 1117 patients per month by July 2016, with a dramatic increase noted immediately after program implementation in August 2015 (*P* for trend <.01), with testing frequency remaining stably high subsequently (Figure 2). Increases in HCV antibody testing were noted across all groups of age, sex, and race/ethnicity, with significant increases noted among those in the older age groups within the cohort (Table 1). A 205% increase in HCV testing was noted among those in the oldest age group within the birth cohort (ie, 65–71 years) when comparing the numbers tested for HCV antibody preprogram implementation to postimplementation. Among the racial/ethnic groups, testing increased most substantially among Asian and white racial/ethnic groups (by 121% and 151%, respectively). The distribution of HCV antibody testing by age and sex appeared to closely follow the demographic distribution of primary care visits for baby boomers during the time period of interest. Between August 2015 and July 2016, 54.5% of primary care visits among those in the birth cohort was among women and 45.5% of visits was among men, mirroring the distribution of HCV testing (53.5% women and 46.5% men).

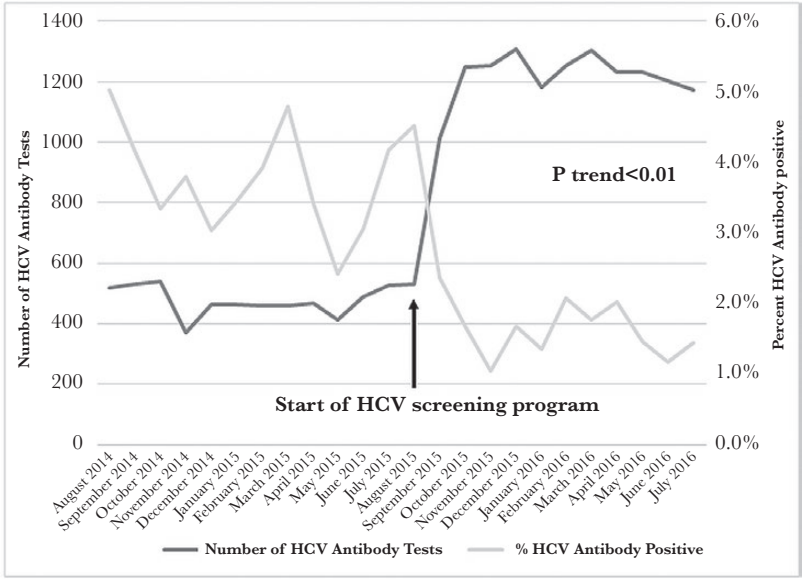

Figure 2. Hepatitis C virus (HCV) antibody testing and percentage positivity before and after implementation of an HCV screening program among baby boomers tested through UCLA Health system, August 2014–July 2016.

Not surprisingly, as testing increased, HCV antibody positivity declined from an average of 4.1% preprogram implementation to 1.5% after program implementation (P value for trend <.01) (Figure 2). In the year before program implementation, a total of 5676 patients were tested for HCV antibody; in the year after program implementation, the number tested increased to 13 930 patients, representing a 145% overall increase in testing. Hepatitis C virus antibody positivity varied by age and sex, with a higher prevalence among those aged 60–64 years than 49–54 years (2.6% vs 1.6%; P value < .01) and a higher prevalence among males compared with females (3.1% vs 1.5%; P < .01) (Table 2). Hepatitis C virus antibody positivity differed by race/ethnicity, with the highest prevalence noted among African Americans (4.4%) followed by Hispanics (4.1%) in the postimplementation period (P < .01). Hepatitis C virus RNA was detected (postimplementation) in 44% of those testing antibody positive. No differences were noted in HCV RNA detection by age or race/ethnicity, although the proportion with detectable HCV RNA was higher among men compared with women (50% vs 39%; P = .01).

Although the proportion of HCV antibody positivity declined with increased testing, there was a modest increase in the absolute number of those testing HCV antibody positive during the postimplementation period, most notably among 60- to 71-year-olds (from 72 positive tests preimplementation to 146 positive tests postimplementation, a 103% increase) and women (from 66 to 90 positive tests, a 36% increase).

In addition, inclusion of an HCV care coordinator appeared instrumental in maintaining high levels of uptake across the HCV care continuum. In the period after the addition of the HCV care coordinator, the percentage of HCV antibody positive patients who received HCV RNA testing increased from 83% (pretreatment coordinator) to 95% (P < .01) (Figure 3). The absolute number of those identified with active HCV infection (ie, HCV RNA positive) increased from 40 in the preimplementation to 49 in the postimplementation period (Figure 3). The HCV care coordinator was successful in facilitating linkage to care for 94% of those identified as HCV RNA positive, a modest (nonsignificant) increase from the preimplementation period.

DISCUSSION

Introduction of an HCV screening reminder through an EHR CDS tool led to a marked increase in HCV testing among the birth cohort, demonstrating the effectiveness of an EHR intervention to facilitate uptake of guideline-based recommendations throughout a large health system. The increase in testing suggests acceptance of the EHR reminder by providers. Acceptance of the reminder was likely facilitated by (1) a substantial investment in engaging and obtaining the support of key stakeholders and health system leadership and (2) minimal disruption to physician workflow as HCV screening was added to an existing health maintenance reminder. Clinical decision support tools have been implemented for other screening and prevention recommendations including colorectal cancer screening, resulting in higher screening rates over time among physicians receiving EHR reminders [8].

The EHR intervention increased HCV screening similarly to electronic interventions in other studies [9, 10]. The simplicity and low cost of the EHR intervention and widespread use of EHR systems with health maintenance reminders or other CDS tools suggests that our EHR intervention may work across

Table 2. HCV Antibody Positivity Before and After Implementation of an HCV Screening Program Among "Baby Boomers", UCLA Health System, August 2014–July 2016

	August 2014–July 2015 (n = 5676)[a]		August 2015–July 2016 (n = 13930)[a]		Total (n = 19606)		
Patient Characteristics	n	%	n	%	n	%	P Value*
Age, years							<.01
49–54	45	2.4	43	1.2	88	1.6	
55–59	63	4.1	53	1.5	116	2.3	
60–64	45	3.7	76	2.2	121	2.6	
65–71	37	3.5	68	2.1	105	2.4	
Sex							<.01
Female	66	2.1	90	1.2	156	1.5	
Male	124	5.0	150	2.3	274	3.1	
Race/Ethnicity							<.01
Asian	14	2.7	13	1.1	27	1.6	
Black or African American	23	5.5	29	3.9	52	4.4	
Hispanic or Latino	36	5.2	46	3.4	82	4.1	
Other	14	4.0	19	2.2	33	2.7	
White	89	2.8	102	1.3	191	1.7	

Abbreviations: HCV, hepatitis C virus; UCLA, University of California, Los Angeles.

[a]Sum may not equal to total due to missing data.

*P value reflects comparisons of HCV antibody positivity for each demographic characteristic.

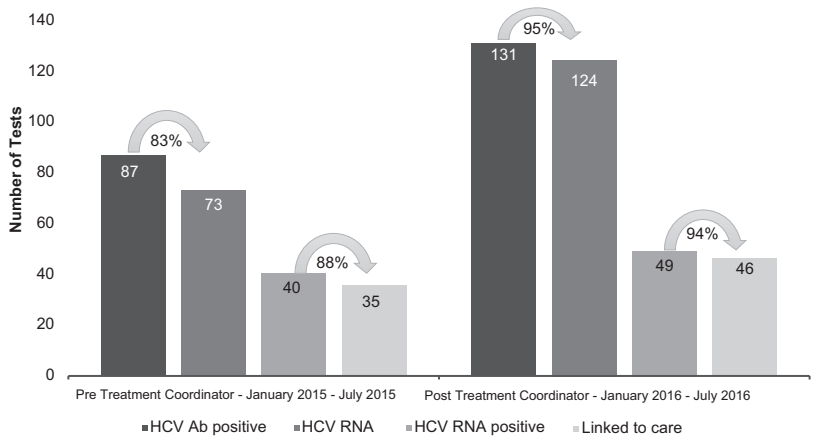

Figure 3. Absolute number of hepatitis C virus (HCV) antibody positive, HCV ribonucleic acid (RNA) tested, HCV RNA positive, and linked to care, before and after addition of a HCV care coordinator.

different health systems. The impact of a dedicated care coordinator on follow up of HCV RNA testing and linkage to care is also likely generalizable to other health systems, because the function of the coordinator can easily be reproduced and the use of a care coordinator might be cost effective. Our study demonstrated that a clinically trained coordinator is not required to link individuals to care effectively and thus nonclinically trained professionals may be more affordable for other health systems.

In the BEST-C Study, the cost of different approaches to screening was assessed, comparing an electronic best practices alert (BPA) as well as medical assistant placement of an HCV test order with repeated mailing and patient solicitation [10]. The authors found that the BPA intervention had the lowest incremental cost per HCV antibody test completed, an approach for which, similar to the intervention in the current study, there were initial start-up costs for information technology related development of the BPA and staff training, but no subsequent costs assessed for implementation. It is notable that in BEST-C, but not in the approach reported in the current study, personnel effort was included in the intervention to initiate an HCV test order, but the ongoing cost of the medical assistant (beyond initial training) was not included in the calculation of the cost of the BPA arm. The cost of programming the EHR health maintenance reminder is expected to be lower than that of programming a BPA, but the uptake of a health maintenance reminder and BPA may differ and influence its cost effectiveness.

Testing increased most notably in select subgroups of older age, Asian, and whites, groups that may have previously been perceived as lower risk by healthcare providers. As testing increased, we saw an expected decrease in HCV antibody positivity, consistent with a shift to screening based predominantly on birth cohort status, whereas preprogram implementation screening may have included a combination of risk factor-driven testing (enriching the population with HCV infection) with some birth cohort-based screening. The previous approach would have been more subjected to provider bias or lack of awareness regarding risk factors for HCV infection, leading to underscreening of the target population [11].

The prevalence of HCV antibody positivity in our cohort (1.5%) is lower than that observed in other studies of HCV screening in baby boomers, likely due to differences in the sociodemographic makeup of the UCLA Health patient population compared with other cohorts. Jonas et al [9] described a prevalence of 3.25% in a Kaiser Permanente cohort from Maryland, Virginia, and the District of Columbia, and Goel et al [12] described a prevalence of 3.3% in a New York City university-based primary care cohort of persons born between 1945 and 1965; both groups showed a greater proportion of black and Hispanic patients. A review of HCV seroprevalence in state prisons showed a wide range of seroprevalence from 7.5% to 41.2% between states, and the prevalence among Hispanic subpopulations also varies by Hispanic/Latino background and city, with the highest prevalence described in the Bronx and lower prevalence in Chicago, Miami, and San Diego [3, 13]. The lower HCV seroprevalence in our study may also be explained by differences in the selection of the study population, whereby we used both previous laboratory testing in the EHR as well as chart review to exclude previously diagnosed cases of HCV. Other cohorts only excluded cases based on laboratory testing available in the EHR, sometimes within limited periods, thus potentially including more patients with known HCV infection. We did observe a higher prevalence of HCV antibody positivity among African Americans and men in our cohort, consistent with other studies [9, 14–16].

A lower HCV RNA positivity than expected was also observed in our cohort, with a proportion of 44% in the post-implementation/postcare coordination period compared with 75.9% and 84% in other studies [9, 12]. Those differences may also be explained in part by differences in the racial/ethnic makeup of the cohorts, as black or African American individuals have a lower rate of spontaneous HCV clearance compared

with whites, which is partly explained by host genetic differences [17], and our cohort had a smaller proportion of black patients.

Our findings support the use of CDS and dedicated HCV care coordination to successfully scale-up HCV screening and linkage to care within a health system. Barriers to successful linkage were minimal in the postimplementation period, as noted in Figure 3. The only barrier to linkage identified was patients stating that they were not ready for an appointment with an HCV specialist at the time they received a call from the HCV care coordinator.

There were other external factors to consider as possible limitations to the interpretation of our findings, such as ongoing advertisements in the media and other news reports as well as changes in legislation, litigation, and policy related to HCV that we were unable to control for in this study. Another factor influencing higher screening might have been changes in the number of clinical sites served over the observation period. Those factors may have influenced higher screening and linkage to care rates as awareness about HCV and available treatments in the general population increased. Although those factors might have influenced higher screening and linkage to care rates, the sharp increase in screening and lack of continued increase over time suggest that the impact of those factors was minimal. A further limitation is that the CDS tool required activation as well as purposeful review by providers, and thus not all providers would have been reminded of the screening recommendation. Follow-up HCV RNA testing to assess for active HCV infection also required a provider to order HCV RNA testing and that the patient return for follow-up specimen collection. To address those barriers to screening and confirmation of HCV infection, the allowance of a dedicated staff member to activate the CDS tool on all patients and the use of reflex HCV RNA testing for positive HCV antibody tests could further improve outcomes [9]. Implementation of the screening program required (1) health system leadership and (2) participation from various departments that might limit feasibility in a more resource-constrained health delivery setting.

An additional limitation of the study was that the preimplementation data were collected retrospectively. Approximately 20% of the anti-HCV positive patients in that period had missing HCV RNA testing data. It is possible that some patients in the preimplementation period had screening or follow up outside of UCLA that was not captured.

CONCLUSIONS

Implementation of national guidelines for HCV screening at the health system level through a multipronged approach, including decision support tools within the EHR and dedicated care coordination, although requiring substantial initiative, has the potential to rapidly scale up HCV screening and reduce gaps at every step in the HCV care cascade. With the current availability of highly effective and well tolerated curative HCV therapy, such an investment is likely to have an impact on decreasing the HCV-related disease burden, improving patient outcomes, and reducing future healthcare costs.

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Potential conflicts of interest. K. W. C. reports other funding from the Gilead Focus Award, during the conduct of the study; and grants from Merck Sharp & Dohme, outside the submitted work. S. S. is a part of the advisory board, a consultant, and on the speaker bureau for AbbVie, BMS, Gilead, Janssen, and Merck.

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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