**Name of Journal**: ***World Journal of Hepatology***

**Manuscript NO: 37718**

**Manuscript Type**: **Original Article**

***Clinical Practice Study***

**Hepatitis C virus knowledge improves hepatitis C virus screening practices among primary care physicians**

Samuel ST *et al.* HCV knowledge improves primary care screening

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**Author****contributions:** Samuel ST, Martinez AD and Talal AH contributed to conception of the study, obtaining regulatory approval, data collection and input on the analysis; Chen Y and Markatou M contributed to direction and conduct of statistical analysis; All authors contributed to drafting and approval of final manuscript.

**Supported by** Troup Fund of the Kaleida Health Foundation and the Patient-Centered Outcomes Research Institute (PCORI), NO. IHS-1507-31640. The statements in this work are solely the responsibility of the authors and do not necessarily represent the views of PCORI, its Board of Governors or Methodology Committee.

**Institutional review board statement:** The Health Sciences Institutional Review Board (HSIRB) at the University at Buffalo reviewed the study protocol and deemed the study met exempt criteria 45 CFR 46.101(b)(2). The permissible exempt category was “Research involving the use of educational tests, survey procedures, interview procedures or observation of public behavior (anonymous survey)”.

**Informed consent statement:** The HSIRB considered the return of the anonymous survey as deemed voluntary consent to participate in the study and therefore did not require an individual consent form from each participant.

**Conflict-of-interest statement:** Martinez AD has served as a speaker, a consultant and an advisory board member for Gilead, Intercept, Salix, Bayer, BMS, and Abbvie, and has received research funding from Abbvie, Gilead, Merck, Tobira, and Intercept; Talal AH has served as a speaker, a consultant and an advisory board member for Abbott Laboratories, Merck, and Abbvie, and has received research funding from Merck, Gilead, Abbott Laboratories, Abbvie, Intercept and Conatus; None of the other authors have any financial disclosures.

**Data sharing statement:** HSIRB approval permitted data sharing of the results of the study.

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**Manuscript source:** Unsolicited manuscript

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**Received:** January 1, 2018

**Peer-review started:** January 2, 2018

**First decision:** January 15, 2018

**Revised:** January 17, 2018

**Accepted:** February 3, 2018

**Article in press:**

**Published online:**

**Abstract**

***AIM***

To understand the role of knowledge as a promoter of hepatitis C virus (HCV) screening among primary care physicians (PCP).

***METHODS***

A 45-item online questionnaire assessing knowledge of HCV natural history, risk factors, and treatment was distributed to 163 PCP. Logistic regression, adjusted for survey responses, assessed associations between PCP knowledge of HCV natural history and treatment and birth cohort (*i.e*., birth between 1945 and 1965) screening. Response stratification and weighting were used to account for nonresponse and to permit extension of responses to the entire survey population. Associations between various predictors including demographic characteristics, level of training, and HCV treatment experience and HCV knowledge were assessed.

***RESULTS***

Ninety-one individuals (55.8%) responded. Abnormal liver enzymes (49.4%), assessment of HCV-related risk factors (30.6%), and birth cohort membership (20%) were the leading HCV screening indications. Most PCP (64.7%) felt that the combination of risk-factor and birth cohort screening utilizing a self-administered survey while awaiting the physician (55.3%) were the most efficient screening practices. Implementation of birth cohort screening was associated with awareness of the recommendations (*P*-value = 0.01), knowledge of HCV natural history (*P*-value < 0.01), and prior management of HCV patients (*P*-value < 0.01). PCP with knowledge of HCV treatment was also knowledgeable about HCV natural history (*P*-value < 0.01). Similarly, awareness of age-based screening recommendations was associated with HCV treatment knowledge (*P*-value = 0.03).

***CONCLUSION***

Comprehensive knowledge of HCV is critical to motivate HCV screening. PCP-targeted educational interventions are required to expand the HCV workforce and linkage-to-care opportunities as we seek global HCV eradication.

**Key words**: Viral hepatitis; Hepatitis C virus global eradication; Hepatitis C virus diagnosis; Hepatitis C virus surveillance; Knowledge of hepatitis C virus

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**Core tip:** Many hepatitis C virus (HCV)-infected patients worldwide are unaware of their infection status. The key to increasing HCV detection and linkage-to-care is augmentation of virus screening by primary care physicians (PCP). Understanding factors that promote HCV screening among PCP is crucial to its eradication. We assessed PCP knowledge of HCV natural history and treatment and awareness of screening recommendations. PCP knowledge of HCV natural history and prior management of HCV patients were important predictors of implementation of HCV screening. Comprehensive HCV education targeted to PCP, including screening recommendations, is critical to increase HCV detection and linkage-to-care to obtain global eradication.

Samuel ST, Martinez AD, Chen Y, Markatou M, Talal AH. Hepatitis C virus knowledge improves hepatitis C virus screening practices among primary care physicians. *World J Hepatol* 2018; In press

**INTRODUCTION**

Hepatitis C virus (HCV) is a leading cause of cirrhosis that can ultimately result in end-stage liver disease, hepatocellular carcinoma[1], and liver transplantation[2,3]. An estimated 5.2 million individuals in the United States are HCV-infected[4]. HCV mortality continues to increase, and it now surpasses the combined mortality of 60 notifiable infectious diseases[5]. Simultaneously, direct acting antivirals (DAAs) have improved HCV treatment tremendously; all oral, highly efficacious agents with minimal side effects and short treatment duration. HCV elimination in the United States, an often cited goal, is substantially hampered since 40% of HCV-infected patients are unaware of their infection status[6], and the 20000 Gastroenterology-Hepatologists and Infectious Diseases physicians[7] in the United States are insufficient to care for up to 5 million HCV-infected individuals[4].

Historically, primary care physicians (PCP) had a role in HCV detection and counseling, but HCV treatment was considered beyond their practice scope[8], a notion that has recently been challenged[9,10]. Many PCP, the gatekeepers of the healthcare system, have limited HCV knowledge[11,12]. A systematic review identified significant knowledge gaps among PCP related to HCV natural history, diagnostic approaches, and treatment[12]. The rapid change in the HCV therapeutic landscape has only magnified the need for HCV education. Indeed, a recent survey indicated that the vast majority (84%) of PCP desired additional HCV training[13]. Delivering HCV education to resident physicians may effectively increase HCV knowledge among PCP. Indeed, most Family Medicine residency training program directors believe that chronic HCV is a significant primary care problem and PCP should be involved in building capacity for HCV management[14]. PCP education on HCV natural history and treatment has also been shown to expedite HCV treatment, adherence, and viral eradication[15,16].

Strategies have also been implemented to increase identification of HCV-infected individuals who remain undiagnosed. In 2012, the Centers for Disease Control and Prevention (CDC) and the US Preventive Services Task Force (USPSTF) promoted the recommendation that all individuals born between 1945 and 1965 (*i.e.,* birth cohort) should have a one-time HCV screening test[17,18], since 75% of undiagnosed HCV–infected individuals are birth cohort members[19]. Unfortunately, however, limited implementation of birth cohort screening has diminished its originally anticipated impact with screening rates that are substantially reduced compared to those originally proposed and that vary widely from institution to institution[20,21]. Limited PCP knowledge of birth cohort screening recommendations may partially account for diminished impact. Indeed, systematic reviews have established the pre-eminent role of provider education in successful implementation of quality of care clinical guidelines[22]. Education should target uncertainties in physician knowledge and should be modified over time in order to ensure continued guideline application[23].

In consideration of PCP’ expanding role in HCV treatment[9,10,14] combined with the need for knowledge on HCV natural history, screening, and treatment[12], we assessed knowledge of HCV natural history and treatment on implementation of birth cohort screening recommendations. We surveyed 91 PCP affiliated with an academic medical center. We sought to provide insight into topics for provider education, particularly to physicians in training, as these are important considerations in order to expand the HCV workforce.

**MATERIALS AND METHODS**

***Study population and eligibility***

The University at Buffalo (UB)-affiliated primary care clinics is a network of 9 clinics catering to urban and suburban patients in and around the City of Buffalo, New York. Eligible participants were PCP working in UB-affiliated clinics as supervising physicians or residents and who had experience with HCV treatment. Participant’s scope of practice was General Internal Medicine, Family Medicine or a related combination of the two in such disciplines as Pediatrics or Social and Preventive Medicine. Medical students and physician extenders (*i.e*., nurse practitioners or physician assistants) were excluded from the study. The study was deemed exempt from review by UB’s Health Sciences Institutional Review Board and it considered the return of the anonymous survey as deemed voluntary consent.

***Hypothesis, questionnaire development and administration***

The primary objective of this study was to evaluate the association of PCP knowledge of natural history and treatment of HCV on the implementation of birth cohort-based HCV screening. As a secondary objective, we sought to evaluate PCP related factors that could influence implementation of birth cohort-based HCV screening. We hypothesized that PCP with greater knowledge of HCV natural history and treatment would be more likely to implement birth cohort-based screening for HCV. The study design was a prospective questionnaire-based single-site study. Over a six month period, eligible PCP were distributed an anonymous, web-based 45 question survey that contained 18 knowledge questions that assessed HCV natural history and 19 that assessed knowledge of HCV treatment. Survey completion took approximately 30 minutes. Physicians who did not respond to the initial request or who partially completed the initial survey were sent follow up completion reminders weekly. No gifts or incentives were offered for survey completion. The survey instrument also inquired about general information concerning PCP practice locations and specialties.

***Testing for internal validity and data analysis***

After initial questionnaire development by subject matter experts, the survey was pretested among 5 providers. Based upon responses received, changes were made to the survey lay-out and format. The final version of the questionnaire was then distributed for completion. The internal validity of the survey was evaluated by including questions with similar meaning and by checking for agreement in the responses. We found that agreement between questions was moderate (kappa statistic estimate: 0.536; *P* < 0.01).

Statistical analysis was performed using R (http://www.r-project.org/). Categorical variables are summarized as counts and/or percentages, while continuous variables are summarized by their mean/median and standard deviation/interquartile range, as appropriate. Kappa statistic was used to evaluate agreement between paired dichotomous data. Knowledge of HCV natural history and treatment were evaluated as the number of correctly answered questions. To estimate the density of the scores, we used kernel density estimation methods with a Gaussian kernel and the corresponding bandwidth parameter was automatically selected *via* the R function “density”. Logistic regression was used to assess the effect of patients’ characteristics on the birth cohort based screening. Linear regression was used to evaluate the effect of patient characteristics on the knowledge of HCV natural history and treatment. Post-stratification was used to compensate for the fact that physicians with certain characteristics are not as likely to respond to the survey. We use weighting to adjust the regression results with weights being the percentages of the levels of the variable “primary care location” (the response rates of the three levels of this variable are significantly different) thereby extending the results from the responders to the entire population. In linear regression, Box-Cox transformation was used to achieve normality of knowledge of HCV natural history and treatment. The significance level in all tests (2-sided) was set to = 0.05. Predictors that were evaluated for HCV knowledge (both for natural history and treatment) were gender, prior experience in evaluating patients with HCV infection (*i.e*., at least one HCV-infected patient evaluated in past two years), clinical practice locations and level of medical training among those currently in medical training.

**RESULTS**

***Study participants***

A total of 163 surveys were distributed to PCP who were randomly selected from the population satisfying the eligibility criteria, and 91 (55.8%) responded. Baseline characteristics extrapolated to the entire population to whom the survey was distributed and those of the responders are illustrated (Tables 1 and 2, respectively). The survey was distributed to an approximately equal percentage of males and females, most of whom were in training (82.2%), and who had their primary practice location at one of the two principal UB-affiliated hospitals. Among the respondents, 54.9% were male, 45.1% female and 90.1% practiced internal medicine or its combined tracks. Residents in training comprised of 83.5% of the respondents, and the remaining were attending/supervising physicians. Practice location was predominantly a university-affiliated county hospital-based primary care clinic (39.6%). Electronic medical charting was used by 80.2% of the respondents.

***PCP knowledge of HCV natural history and treatment***

The distribution of scores indicating the number of correctly answered questions associated with the 18 items that assessed PCP knowledge of HCV natural history is illustrated in Supplementary Figure 1. Figure 1A illustrates the corresponding kernel density of the scores computed using a Gaussian kernel and a bandwidth parameter equal to 1.405. The density plot indicates that knowledge of HCV natural history is spread among three groups: (1) A group with “low” knowledge of HCV natural history, (2) a group constituting the majority of respondents has “moderate” knowledge, and (3) a smaller group of PCP with high knowledge.

The distribution of the scores associated with the 19 questions that assessed PCP knowledge of HCV treatment is illustrated in Supplementary Figure 2. Scores are calculated as previously, that is, each question that is answered correctly receives 1 point, for a total of 19 points. In contrast to the results obtained for HCV natural history knowledge, using a Gaussian kernel with bandwidth parameter 1.394, The corresponding density plot (Figure 1B) illustrates that most PCP have knowledge scores greater than 10 with general knowledge symmetrically distributed around a score of 11.

**Predictors of PCP knowledge of HCV natural history and treatment:** We next utilized linear regression to evaluate the association between various predictors and two principle outcome measures, knowledge of HCV natural history and of HCV treatment. Both outcome variables are represented by the total scores obtained in answering the relevant questions and are of interval scale. To satisfy the assumption of normality, we use the Box-Cox transformation with $λ$=1.116 for the scores corresponding to knowledge of HCV treatment and with $λ$=1.75 for the scores corresponding to knowledge of HCV natural history. Further, the percentages from the primary care location variable corresponding to the population surveyed (20.25%, 34.35%, and 45.40%) are treated as weights for the observations. In this way, we adjust the regression results to also include those who did not respond to the survey.

We found that knowledge of HCV natural history is significantly associated with knowledge of HCV treatment (*P*-value < 0.01), after adjusting for all relevant predictors (Table 3). That is, PCP with higher knowledge of HCV treatment tended to have higher knowledge of HCV natural history. Also, we found that knowledge of HCV treatment is significantly associated with awareness of the age-based screening recommendation (*P*-value = 0.03, Table 4), indicating that PCP who are aware of the age-based screening recommendation for HCV tend to have higher knowledge of HCV treatment. These findings suggest knowledge of HCV natural history is a prerequisite for knowledge about HCV treatment. Similarly, those who were aware of age-based HCV screening recommendations also scored better on the HCV knowledge assessment.

**Predictors for implementation of birth cohort-based screening:** Next we focused on implementation of the age-based screening recommendation. As this is the primary outcome variable of interest, we used logistic regression to identify potential significant associations between this variable and a number of predictor variables. As above, we treat the percentages from the primary care location variable as weights for the observations to adjust the results for those invited but who did not complete the survey. We found that the implementation of age-based screening for HCV is significantly associated with knowledge of HCV natural history (*P*-value < 0.01), with awareness of birth cohort based screening (*P*-value = 0.01), and with whether the PCP had seen HCV patients previously (*P*-value < 0.01) (Table 5). Therefore, PCP who have higher HCV natural history knowledge levels, who have not seen HCV patients in the past two years, and who are aware of birth cohort recommendations for HCV are more likely to implement age-based screening in their practices.

**Analysis of reasons for and appropriateness of obtaining an HCV screening test:** At the time of the survey, the majority of the PCP had ordered an HCV screening test in the recent past (88.2%) (Table 6). Of the reasons that PCP decided to pursue HCV screening, the leading reason (49.4%) was abnormal liver function or other biochemical tests while 30.6% of the PCP cited HCV risk factors, and 20% cited membership in the “birth cohort” as the leading reasons to screen for HCV. In terms of PCP ordering the appropriate screening test, 55.3% of the respondents identified the correct initial screening test as the HCV antibody. In addition, 28.2% of the PCP indicated that they do not follow any society guidelines when ordering an HCV screening test.

We also assessed PCP HCV screening practice patterns including how often PCP assessed HCV-related risk factors (Table 7). A total of 81.2% of providers assessed for HCV risk factors at least sometimes. In terms of how the knowledge of the presence of HCV risk factors was utilized, 68.2% of PCP frequently or always ordered an HCV screening test after identification of at least one HCV risk factor. Documentation of a discussion with the patient concerning screening and risk assessment was performed always or often by 23.5% of PCP, whereas 14.1% never documented the screening discussions and risk assessment in the patient’s chart.

**PCP perceptions to screening for HCV:** With regards to HCV screening, only 30.6% of PCP was satisfied with the existing screening approaches utilized at their practice site (Table 8). The most effective strategy to screen patients in the clinic was incorporation of both risk-based and birth cohort-based screening. We also evaluated the PCP’s perception as to the most effective way to initiate HCV screening, to which 55.3% suggested that having the patient complete a screening questionnaire during the waiting period prior to the evaluation was the most effective strategy.

**PCP barriers to screening for HCV:** We next evaluated PCP-identified barriers in their practice location for effective screening for HCV (Table 9). Constraints in the allotted time with the patient to obtain all risk factors were cited as a barrier by 14.1% of participants. An additional 14.1% mentioned that unawareness of screening guidelines among PCPs was a barrier to HCV screening. Lack of a pre-set health maintenance evaluation protocol for the clinic location, such as automatic stop prompts and screening alerts, in combination with the above two reasons were cited as barriers by 16.4% of participants. Other reasons were mentioned by 55.3% of respondents and are described in the last column of Table 9.

**DISCUSSION**

The development of DAAs has resulted in the need for significant expansion in the number of providers who can treat HCV. While PCP have always had a role in detection and counseling for HCV[8], their scope of practice is expanding to include HCV treatment. Several recent studies have documented equivalent HCV eradication rates whether patients were treated by PCP, hepatologists, or infectious diseases physicians[9,10]. Recent investigation has also documented that Family Medicine training program directors believe that HCV is a significant problem for Family Physicians and that HCV education should be part of their training curriculum[14]. As limited data exist on PCP knowledge of HCV natural history, screening and treatment and the effect of this knowledge on implementation of age-based screening, we performed this investigation primarily to understand the factors associated with implementation of HCV screening recommendations and to identify gaps in HCV-related knowledge among PCP.

Broadly, we found that knowledge of HCV natural history is a prerequisite for implementation of HCV screening. More specifically, we found that knowledge of particular recommendations, in this case those associated with birth cohort screening, were necessary for their implementation. We also observed that knowledge of HCV treatment was significantly associated with knowledge of HCV natural history, indicating the need to educate PCP about the entire HCV disease process. Among our survey respondents, laboratory abnormalities were the single most important indication to screen for HCV as opposed to screening based upon guideline implementation, and most PCP endorsed the combination of risk-factor and birth cohort screening utilizing a self-administered survey. These findings indicate that HCV educational interventions targeted toward PCP should be comprehensive covering all aspects of the infection. Furthermore, they should emphasize guideline-based screening recommendations.

We found that PCP knowledge of the natural history of HCV positively impacts the implementation of birth cohort based screening by PCP. Increasing HCV screening is required to identify the 40% of HCV-infected individuals who are unaware of their infection status[6], so that the stated national goal of HCV elimination can be realized[24]. Substantial HCV-related knowledge and familiarity with HCV screening may enable PCP to offer HCV treatment thereby providing additional linkage-to-care opportunities[25]. A recent study reported that only 22% of PCP believed they should treat HCV. PCP who managed a high proportion of HCV-infected patients and practices that actively managed a variety of related conditions (HIV, mental health and substance use disorders) were factors significantly associated with a higher likelihood of offering HCV treatment[13]. HCV education targeted to PCP is likely to play an important role in increasing the number of treating physicians.

Ongoing HCV education to PCP is also required given the rapid progress in our understanding of HCV natural history and recent therapeutic advances. For example, recent data have confirmed all-cause and liver-specific mortality reductions as a result of HCV eradication[26-30]. Similarly, further PCP education is needed not only on when to screen, *i.e.,* basing screening on guidelines instead of on clinical abnormalities, but how to screen. Indeed, we would encourage pharmaceutical companies to continue to invest in PCP education through sponsorship of educational programs targeted to PCP. Our survey revealed that many PCP continue inappropriate and ineffective HCV screening strategies, such as obtaining aminotransferase or HCV RNA levels, instead of obtaining an initial HCV antibody assessment.

Physician engagement is crucial to successful guideline implementation, and an initial crucial step is guideline awareness[31]. Our study illustrates that physician knowledge of HCV natural history, as well as awareness of birth cohort screening recommendations, were associated with age-based screening implementation. PCP knowledge of HCV treatment did not predict implementation of birth cohort screening, but was associated with knowledge of natural history of HCV. PCP knowledge gaps have been cited as obstacles to liver disease screening for hepatocellular carcinoma surveillance among cirrhotic patients[32] and in hepatitis B[33] infection. Education targeted to patients may also improve screening and linkage to care. Consequently, education to both providers and to patients is extremely important toward achieving HCV elimination. Linking HCV screening with treatment programs will also be tremendously important toward achieving the goal of eradication.

Study strengths include a reasonable number of survey responses obtained from physicians in training, an important population for HCV treatment workforce expansion. Furthermore, we obtained a reasonable response rate obtaining responses from one half of those to whom the survey was distributed. Additionally, weighting PCP responses permitted inference to those physicians who did not complete the survey, and we also assessed the instrument’s internal validity. Study limitations include responses largely from PCP in training at an academic medical center, which may affect generalizability to community-based PCP. Additional limitations include a relatively small sample size and responses obtained *via* a self-administered online questionnaire. Future investigation should endeavor to include additional respondents at other academic centers.

HCV-related knowledge gaps among PCP must be addressed in order to increase the HCV workforce leading to increased opportunities for HCV screening and engagement into care. Our study illustrates how PCP knowledge of HCV natural history and treatment can influence birth cohort-based screening practices. It also provides insights into PCP attitudes and barriers toward HCV screening in the primary care setting. As PCP engagement is paramount to successful intervention implementation, our highlight topics needed for provider-based educational interventions designed to optimize HCV screening in clinical practice.

**ARTICLE HIGHLIGHTS**

***Research background***

In order to achieve global hepatitis C virus (HCV) eradication, it is crucial to increase HCV diagnosis and linkage-to-care.

***Research motivation***

In many countries, primary care physicians (PCP) care for those who are HCV-infected yet undiagnosed. Increasing PCP willingness to screen and to treat HCV is crucial to its global eradication. Understanding promotors or barriers to HCV screening and linkage-to-care among PCP, especially the role of knowledge of the infection and screening guidelines, is crucial to expansion of the HCV workforce.

***Research objectives***

We sought to assess PCP knowledge about HCV natural history and treatment as well as with regard to implementation of birth cohort screening recommendations.

***Research methods***

We administered a 45-item survey to 163 PCP, 82% of whom were in training in Internal or Family Medicine.

***Research results***

PCP knowledge of HCV natural history and prior management of HCV patients were important predictors of implementation of HCV screening. Clinical abnormalities remained the leading indication for ordering an HCV screening test.

***Research conclusions***

Comprehensive HCV education targeted to PCP, including screening recommendations, is critical to increase HCV detection and linkage-to-care to obtain global eradication. Familiarity with HCV management increased the likelihood that PCP would care for HCV-infected patients.

***Research perspectives***

Increasing physician education should lead to increased HCV screening. Linking HCV screening to treatment is crucial to obtain global HCV eradication.

**ACKNOWLEDGMENTS**

We acknowledge the contribution of Elizabeth George, MD, Sumeet Munjal, MD, and Miles Basil, MD,for assistance with data collection.

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**P-Reviewer:** Ferraioli G, Jarcuska P, Komatsu H, Stanciu C, Tarantino G

**S-Editor:** Cui LJ **L-Editor: E-Editor:**

**Specialty type:** Gastroenterology and hepatology

**Country of origin:** United States

**Peer-review report classification**

Grade A (Excellent): 0

Grade B (Very good): B, B, B

Grade C (Good): C, C

Grade D (Fair): 0

Grade E (Poor): 0





**Figure 1 Distribution of responses for knowledge of hepatitis C virus (HCV) natural history and treatment.** A: Plot of the density of scores for the variable “Knowledge of HCV Natural History”. The density estimation uses a Gaussian kernel with bandwidth 1.405. The data illustrate that HCV natural history knowledge is spread among three separate groups: those with low knowledge, the majority that has moderate knowledge, and a smaller group with vast knowledge; B: Plot of the density of scores for the variable “Knowledge of HCV Treatment”. The density estimation uses a Gaussian Kernel with bandwidth 1.394. The plot illustrates the distribution of scores for primary care physicians (PCP) knowledge of HCV treatment. Out of a total of 19 possible points, most PCP knowledge scores were greater than 10 with knowledge symmetrically distributed around a score of 11.

|  |
| --- |
| **Table 1 Information about the entire population invited to complete the survey (*n* = 163)** |
| **Variable** | **Total** | **Level** | ***n*** | **Percent** |
| Completed survey | 163 | No | 72 | 44.2  |
| Yes | 91 | 55.8  |
| Gender | 163 | Female | 80 | 49.1  |
| Male | 83 | 50.9  |
| Primary practice location | 163 | Buffalo general medical center | 33 | 20.3  |
| Erie county medical center | 56 | 34.4  |
| Others | 74 | 45.4  |
| Role in primary care clinic | 163 | Resident in training | 134 | 82.2  |
| Supervising physician/attending  | 29 | 17.8  |
| Level of training1 | 143 | Resident PGY1 | 48 | 33.6  |
| Resident PGY2 | 44 | 30.8  |
| Resident PGY3 | 40 | 28.0  |
| Resident PGY4 and above | 11 | 7.7  |
|  |  |  |  |  |

1Twenty subjects had missing values the variable “level of training”. PGY: Post-graduate year.

**Table 2 Baseline characteristics of those individuals who responded to the survey (*n* = 91) from among the entire population invited to complete the survey (*n* = 163)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Total1** | **Level** | **Count/ Mean** | **Percent / SD** |
| Gender | 91 | Male | 50 | 55.0  |
| Female | 41 | 45.1  |
| Specialty of practice | 91 | Family medicine | 9 | 9.9  |
| Others | 82 | 90.1  |
| Primary practice location | 91 | Erie county medical center | 36 | 39.6  |
| Buffalo general medical center | 29 | 31.9  |
| Others | 26 | 28.6  |
| Evaluated at least one hcv patient in past 2 yr | 90 | Yes | 47 | 52.2  |
| No | 31 | 34.4  |
| Not Sure | 12 | 13.3  |
| Role in primary care clinic | 91 | Supervising physician/attending  | 15 | 16.5  |
| Resident in training | 76 | 83.5  |
| Level of training | 85 | Resident PGY1 | 25 | 29.4  |
| Resident PGY2 | 30 | 35.3  |
| Resident PGY3 or above | 30 | 35.3  |
| Awareness of age-based rule for screening | 85 | Yes | 49 | 57.6  |
| No | 36 | 42.4  |
| Implementation of age-based rule for screening | 85 | Yes | 34 | 40.0  |
| No | 51 | 60.0  |
| Knowledge of HCV natural history | 85 | Scores from 0 to 18　 | 10.6 | 4.7  |
| Knowledge of HCV Treatment | 82 | Scores from 0 to 19 | 11.0 | 2.9  |

1Missing values account for difference between number of responses recorded and the total number of survey respondents (*n* = 91). HCV: Hepatitis C virus; PGY: Post-graduate year.

**Table 3 Regression analysis for Box-Cox transformed knowledge of hepatitis C virus natural history**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Level** | **Estimation** | **SD** | ***P* value** |
| Intercept | 　 | -24.90  | 1.39  | 0.001 |
| Knowledge of HCV treatment | 　 | 5.93  | 0.10  | 0.001 |
| Gender | Male | Reference level |
| Female | 0.04  | 0.54  | 0.94  |
| Primary practice location | Erie county medical center | Reference level |
| Buffalo General Medical Center | 0.54  | 0.77  | 0.49  |
| Others | -0.58  | 0.61  | 0.35  |
| At least one HCV patient in past 2 yr | Yes | Reference level |
| No / Not Sure | -0.54  | 0.65  | 0.41  |
| Level of training | Resident PGY 1 | Reference level |
| Resident PGY 2 | -0.98  | 0.83  | 0.24  |
| Resident PGY 3 and above | 0.06  | 0.78  | 0.94  |
| Awareness of age-based rule for screening | Yes | Reference level |
| No | -0.92  | 0.65  | 0.17  |
| Implementation of age-based rule for screening | Yes | Reference level |
| No | -0.07  | 0.65  | 0.91  |

The table illustrates those factors significantly associated with knowledge of HCV natural history. HCV: Hepatitis C virus; PGY: Post-graduate year.

**Table 4 Regression analysis for Box-Cox transformed knowledge of hepatitis C virus treatment**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Level** | **Estimation** | **SD** | ***P* value** |
| Intercept | 　 | 11.98  | 2.12  | 0.001 |
| Knowledge of HCV natural history | score < 6 | Reference level |
| 6 ≤ score < 15 | -0.68  | 1.38  | 0.62  |
| 15 ≤ score | -2.42  | 1.64  | 0.14  |
| Gender | Male | Reference level |
| Female | 0.31  | 0.86  | 0.72  |
| Primary practice location | Erie county medical center | Reference level |
| Buffalo general medical center | 0.27  | 1.20  | 0.82  |
| Others | -1.44  | 0.95  | 0.13  |
| At least one HCV patient in past 2 yr | Yes | Reference level |
| No / not sure | 0.88  | 1.02  | 0.39  |
| Level of training | Resident PGY 1 | Reference level |
| Resident PGY 2 | 1.51  | 1.30  | 0.25  |
| Resident PGY 3 and above | 1.76  | 1.25  | 0.16 |
| Awareness of age-based rule for screening | Yes | Reference level |
| No | -2.21  | 1.00  | 0.03  |
| Implementation of age-based rule for screening | Yes | Reference level |
| No | 1.01  | 1.01  | 0.32  |

The table illustrates those factors significantly associated with knowledge of HCV treatment. HCV: Hepatitis C virus; PGY: Post-graduate year.

**Table 5 Regression analysis for implementation of birth cohort screening recommendations**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Level** | **Estimate** | **SD** | ***P* value** |
| Intercept | 　 | -4.48  | 2.19 | 0.04  |
| Knowledge of HCV treatment | 　 | -0.02  | 0.11  | 0.86  |
| Knowledge of HCV natural history | 　 | 0.27  | 0.08  | 0.002  |
| Gender | Male | Reference level |
| Female | -0.94  | 0.68  | 0.17  |
| Primary practice location | Erie county medical center | Reference level |
| Buffalo general medical center | 0.77  | 0.81  | 0.34 |
| Others | -0.36  | 0.72  | 0.62  |
| At least one HCV patient in past 2 yr | Yes | Reference level |
| No / not sure | 2.43  | 0.90  | 0.001  |
| Level of training | Resident PGY1 | Reference level |
| Resident PGY2 | 1.57  | 1.18  | 0.19  |
| Resident PGY3 or above | 1.62  | 1.15  | 0.16  |
| Awareness of age-based rule for screening | Yes | Reference level |
| No | -2.32  | 0.88  | 0.01  |

The table illustrates those factors significantly associated with implementation of birth cohort screening recommendations. HCV: Hepatitis C virus; PGY: Post-graduate year.

**Table 6 Primary care physician screening practices for hepatitis C virus infection**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Question** | **Total** | **Option** | **Count**  | **Percent** |
| In the past 2 yr, have you ordered a test with an intention to screen for HCV? | 85 | Yes | 75 | 88.2  |
| No or Not Sure | 10 | 11.8  |
| What is the strongest indication to screen for HCV? | 85 | Risk factor identified on patient encounter | 26 | 30.6  |
| Patients born between 1945-1965 | 17 | 20.0  |
| Abnormal liver enzymes | 42 | 49.4  |
| How have you screened for hepatitis C? | 85 | HCV antibody | 47 | 55.3  |
| Anti HCV antibody and HCV RNA PCR | 11 | 12.9  |
| Other combinations of Anti HCV antibody, HCV RNA, liver function tests, and "let the lab choose" | 27 | 31.8  |
| Do you follow professional society guidelines for HCV screening? | 85 | Yes | 61 | 71.8  |
| No | 24 | 28.2  |

HCV: Hepatitis C virus.

**Table 7 Primary care physician practice patterns for hepatitis C virus screening**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Question** | **Total** | **Option** | **Count** | **Percent** |
| How often are HCV risk factors assessed during a clinic visit? | 85 | Always | 14 | 16.5 |
| Often | 30 | 35.3 |
| Sometimes | 25 | 29.4 |
| Rarely or never | 16 | 18.8 |
| Do you order an HCV screening test after identifying at least one risk factor? | 85 | Always | 28 | 32.9 |
| Often | 30 | 35.3 |
| Sometimes or rarely | 27 | 31.8 |
| Do you document HCV screening discussion/risk factor assessment in the health maintenance section of the patient’s chart? | 85 | Always or often | 20 | 23.5 |
| Sometimes | 24 | 28.2 |
| Rarely | 29 | 34.1 |
| Never | 12 | 14.1 |

HCV: Hepatitis C virus.

**Table 8 Primary care physician perceptions toward screening for hepatitis C virus**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Question** | **Total** | **Option** | **Count** | **Percent** |
| Satisfied with the screening approach in the clinic | 85 | Yes | 26 | 30.6  |
| No | 25 | 29.4  |
| Not Sure | 34 | 40.0  |
| What is the most effective strategy in screening HCV in your clinic | 85 | Incorporate risk based screening | 19 | 22.4  |
| Incorporate birth cohort based screening | 11 | 12.9  |
| Incorporate both risk based and birth cohort screening | 55 | 64.7  |
| Most effect way to initiate screening during a clinic visit | 85 | Have patient fill out a screening questionnaire during wait period | 47 | 55.3  |
| Incorporate mandatory screening questions into EMR | 19 | 22.4  |
| Facilitate screening by use of posters in patient rooms | 9 | 10.6  |
| Printed patient handout about screening  | 10 | 11.7  |

HCV: Hepatitis C virus; EM: Electronic medical record.

**Table 9 Primary care physician identified barriers to screening for hepatitis C virus (*n* = 85)**

|  |  |  |
| --- | --- | --- |
| **Option** | **Count** | **Percent** |
| Inconsistency in offering HCV screening as a part of pre-set health maintenance protocol, time constraints in obtaining all HCV risk factors, unawareness of screening guidelines | 14 | 16.5 |
| Time constraints in obtaining all HCV risk factors | 12 | 14.1 |
| Unawareness of screening guidelines | 12 | 14.1 |
| Other combinations of inconsistency in offering HCV screening as a part of pre-set health maintenance protocol, time constraints in obtaining all HCV risk factors, taboo in asking confidential and personal information as outlined in the screening questionnaire, and unawareness of screening guidelines | 47 | 55.3 |

HCV: Hepatitis C virus.