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Screening and Evaluation of Hepatitis C Virus Infection in Pregnant Women on Opioid Maintenance Therapy: A Retrospective Cohort Study

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Abstract

Background—To describe the delivery of prenatal care services to women with opioid use disorder (OUD) on opioid maintenance therapy at high-risk for hepatitis C virus (HCV) infection.

Methods—Retrospective cohort evaluation of 791 pregnant women with OUD from 2009 to 2012. HCV screening was defined as documentation of (a) an anti-HCV antibody test or (b) a provider discussion regarding a known HCV diagnosis during pregnancy. Multivariate logistic regression was used to identify predictors of HCV screening during pregnancy.

Results—Among 791 pregnant women with OUD, 611 (77.2%) were screened for HCV infection and 369/611 (60.4%) were HCV positive. In multivariable analysis, patients who were married (OR 0.52; 95% CI 0.29, 0.91), used buprenorphine (OR 0.45; 95% CI 0.28, 0.71) and cared for by private practice providers (OR 0.29; 95% CI 0.19, 0.45) were significantly less likely to be screened. In contrast, patients who used benzodiazepines (OR 1.72; 95% CI 1.02-2.92), intravenous (IV) opioids (OR 6.15; 95% CI 3.96, 9.56), had legal problems (OR 2.23; 95% CI 1.12, 4.45), children not in their custody (OR 1.81; 95% CI 1.01, 3.24) and who had a partner with

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AUTHOR CONTRIBUTIONS

EEK contributed to the research conception, design, analysis, interpretation of the results and writing of the manuscript. SLZ, VKR and EBS contributed to the research conception, design and writing of the manuscript. SYP contributed to the analysis, interpretation of the results and writing of the manuscript. SLD contributed to the collection of data and writing of the manuscript.

substance abuse history (OR 2.38; 95% CI 1.23, 4.59) were significantly more likely to be screened. Of 369 HCV positive patients, a new diagnosis of HCV was made during pregnancy for 108 (29.3%) patients. Only 94 (25.5%) had HCV viral load testing, 61 (16.5%) had HCV genotype testing and 38 (10.4%) received an immunization for Hepatitis A. While 285 (77.2%) patients were referred to hepatology, only 71 (24.9%) attended the consultation. Finally, only 6 (1.6%) patients received HCV treatment one year following delivery.

Conclusions—Prenatal care approaches to HCV infection remain inconsistent and the majority of patients diagnosed with HCV infection during pregnancy do not receive treatment after delivery.

Keywords

Hepatitis C virus; Opioid dependence; Pregnancy; Prenatal care screening

INTRODUCTION

Hepatitis C virus (HCV) is a prevalent chronic infection with approximately 16,000 new infections identified each year.[1] Associated with significant morbidity and mortality, HCV infection is responsible for 40% of chronic liver disease and over 30% of liver transplantations in the United States.[1,2] Intravenous (IV) drug use is the most significant risk factor for HCV and is responsible for over 60% of new HCV infections.[1,3] Increasing rates of IVDU have resulted in a rising rate of HCV infection among reproductive aged populations. In 2012, 49% of all cases of acute HCV infection reported to the Centers for Disease Control and Prevention (CDC) were in young people (age < 30) compared to 36% in 2006, with over 75% of individuals reporting a history of IVDU.[4]

Among a growing population of pregnant women with OUD, HCV is also increasing in prevalence. Between 1998 and 2007, the prevalence of HCV in pregnancy increased from 17.0 to 125.1 per 100,000 hospital births.[5] HCV screening during pregnancy is recommended for women with risk factors for HCV exposure and is essential to identify the virus among high-risk women of childbearing age.[2,6-8] Women are more likely than men to use drugs with many partners, share paraphernalia with an injection partner and during pregnancy, will reach their peak likelihood of being infected with HCV.[9] Due to high rates of intravenous opioid use, 40-75% of pregnant women with OUD are HCV positive.[2,10] While intravenous drug use is the primary route of new HCV infections in adults, mother to child transmission is the primary route of new infections in young children and is the leading cause of pediatric chronic HCV infection.[8,11,12] Vertical transmission rates range from 5-10% and is most likely to occur in pregnant women with HCV viral loads greater than 1 million international units/ml at the time of delivery.[7,8,13]

Unfortunately, many high-risk, substance-using women are asymptomatic and unaware of their HCV status.[2] Thus, prenatal care is often one of their first contacts with preventative health care services and may be the only opportunity to identify their HCV infection until later in life.[7,14,15] Frequent prenatal care visits offer multiple opportunities to provide patient education and counseling regarding HCV transmission, disease course and treatment options to prevent further transmission and encourage enrollment in HCV treatment after delivery. Therefore, the purpose of this study is to offer insight into ways to improve the delivery of

health care services to pregnant women with HCV infection. Specifically, we sought to 1) characterize screening for HCV infection in high-risk, pregnant women with OUD, 2) identify gaps in the delivery of prenatal care services to HCV infected women and 3) determine the rate of HCV treatment enrollment.

METHODS

Study sample and setting

The University of Pittsburgh Medical Center (UPMC) is a large, tertiary care, teaching hospital located in a metropolitan area of over two million people. Magee-Womens Hospital (MWH) of UPMC is a large, free-standing women's hospital with approximately 10,000 deliveries per year. At MWH, prenatal and postpartum care is provided to approximately 300 pregnant women with OUD each year according to American College of Obstetricians and Gynecologists (ACOG) recommendations for the care of women with OUD in pregnancy.[15] All patients in our sample were receiving opioid maintenance therapy (either methadone or buprenorphine) at the time of delivery. Patients who used methadone maintenance therapy received their maintenance therapy from a federally licensed methadone treatment facility in the metropolitan area. Patients who used buprenorphine maintenance therapy received their maintenance therapy in an office-based setting from a variety of buprenorphine providers in the metropolitan area.

Dataset

We conducted a retrospective cohort study of all pregnant women with OUD who delivered an infant at MWH between 2009 and 2012. International Classification of Diseases, Ninth Revision (ICD-9) codes for opioid dependence (304.x) were used to identify the sample. Maternal demographics, substance use history, psychosocial risk factors, prenatal care provider type and prenatal care practice patterns associated with HCV screening, evaluation, and treatment were extracted from electronic medical record data including provider progress notes, laboratory data and immunization records. Data extracted from the electronic medical record was validated through a double entry process. A team of researchers experienced in medical record extraction individually and separately extracted each variable from the medical record into two separate databases. These two datasets were then merged and analyzed for discrepancies between the entered data. Each discrepancy was reviewed and resolved by the authors (EK, SD) through a third review of the medical record. This study was approved by the University of Pittsburgh, Institutional Review Board (IRB) # PRO14030301.

Patient and provider characteristics

Substance use history and maternal psychosocial risk factors were extracted from provider documentation in the electronic medical record. Opioid maintenance therapy was defined as maintenance therapy at the time of delivery. Tobacco use was defined as use at any time during pregnancy. Cocaine, non-prescription use of benzodiazepines and marijuana use was defined by a positive urinary toxicology screen at least once during pregnancy. Opioid type and route were self-reported. Maternal psychiatric diagnosis was defined as a diagnosis by a physician at any time either before or during pregnancy. Maternal social risk factors were

self-reported and included: history of or current prostitution, legal problems, homelessness, abuse and children not in maternal custody. Legal problems were defined as a history of or current probation, arrest and/or incarceration. Abuse was defined as history of or current intimate partner violence or sexual abuse. Partner with a substance abuse history was reported by patients without partner confirmation. Prenatal care providers in the academic teaching service included obstetrics and gynecology resident physicians and certified nurse midwives who are supervised by attending obstetrics and gynecology physicians.

HCV screening, evaluation, and treatment

HCV screening was defined as documentation of (a) an anti-HCV antibody test or (b) a provider discussion regarding a known HCV positive diagnosis during pregnancy. A new HCV diagnosis during pregnancy was determined by provider documentation indicating that the patient had not been previously aware of their HCV infection status and/or documentation of patient counseling regarding a new HCV diagnosis. An aspartate aminotransferase (AST) level of 41 international units (IU)/L and an alanine aminotransferase (ALT) level of 54 IU/L are considered the upper limit of normal at UPMC laboratories. AST/ALT levels above these upper limits at any time during pregnancy were considered abnormal. An evaluation of HCV genotype was defined as testing for one of seven genotypes of the HCV species at any time during pregnancy. HCV RNA testing was defined as testing for HCV RNA or viral load by polymerase chain reaction (PCR) at any time during pregnancy. Hepatitis A immunization receipt during pregnancy was defined as documentation of immunization administration and/or provider documentation of immunization receipt in the medical record.

A hepatology referral during pregnancy was determined by provider documentation that a hepatology referral had been made or documentation of a discussion with the patient regarding the importance of hepatology referral in prenatal care progress notes. Hepatology referral attendance was defined as documentation of an outpatient visit with a hepatologist during pregnancy or during one year following delivery. A history of HCV treatment was defined as provider documentation of HCV treatment elicited from the patient during prenatal care visits or documentation from a hepatologist of a history of treatment. Receipt of HCV treatment was defined as documentation of HCV treatment within one year following delivery. The UPMC Department of Obstetrics, Gynecology and Reproductive Sciences and the Department of Gastroenterology, Division of Hepatology share the same electronic medical record system. As a result, hepatology referral and attendance documentation is available in the same medical record as prenatal and postpartum care documentation.

Data analysis and Model development

Descriptive statistics were used to describe demographic characteristics for the population, patterns of prenatal care delivery and the rate of HCV treatment enrollment following delivery for HCV positive patients. Chi square and t-tests were used to test for each variable's association with HCV screening. To select the variables to be included in our multivariate predictive model, we considered statistical significance in our bivariate analyses (chi-square tests and t-tests) and univariate logistic regression analyses, collinearity among

variables as determined by the variance inflation factor (VIF), missing data among variables as well as the clinical relevance of the variables.[16] Variables with p-values < 0.10 from the bivariate analyses or univariate logistic regression models were included as predictors.

Stepwise logistic regression with backward elimination based on the p-values of the coefficient estimates was used to develop the models. That is, starting with the full model, we removed one predictor with the highest p-value from the model, then refit the model with remaining predictors, and then removed another predictor with the highest p-value from the revised model. We repeated this procedure until the p-values of all predictors become less than 0.10 and designated this as the final model.

The predictive performance of our multivariate models were assessed by evaluating the Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) for each model as well as constructing receiver-operating characteristic (ROC) curves, which summarizes sensitivities and specificities of the models on the whole dataset.[17] To evaluate the generalizability of our final model, it was validated using a 10-fold cross-validation procedure which simulates the situation where we apply our model to a new cohort of patients that we did not have the data for at the time of model fitting.[18] Subjects with missing values were excluded from the analysis and a *p*-value of <0.05 was considered statistically significant. All analyses were conducted with STATA® 13 (StataCorp, College Station, TX) and R (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Sample characteristics

The sample consisted of 791 pregnant women with OUD who delivered an infant at MWH between 2009 and 2012. [Table 1 Here] Within this sample, 611 (77.2%) were screened for HCV infection and 369/611 (60.4%) were HCV positive. The mean age of patients in our sample was 27 years old and the majority of patients were Caucasian, single, unemployed, had Medicaid insurance and had a high school education. Approximately two-thirds of patients received their prenatal care from the academic teaching service compared to private practice providers. While all patients received opioid maintenance therapy, the majority of patients used methadone compared to buprenorphine during pregnancy. Over 80% of patients smoked tobacco during pregnancy and approximately one fourth of patients used cocaine, benzodiazepines or marijuana at least once during their pregnancy. Prior to conversion to opioid maintenance therapy, the majority of patients reported a history of heroin abuse compared to prescription opioid abuse and the majority of patients disclosed a history of IV opioid use. Over 70% of patients had a diagnosis of a psychiatric disorder either before or during pregnancy and many patients had multiple social risk factors. Approximately one-fourth of patients reported a history of or current legal problems, abuse (intimate partner violence and/or sexual abuse), had a partner with a history of substance abuse and/or had children who were no longer in their legal custody. Approximately 5% of patients reported a history of or current prostitution and/or homelessness.

Prenatal HCV screening

Bivariate analysis—Maternal demographic data, substance use history and psychosocial risk factors for patients who were and were not screened for HCV during pregnancy were compared [Table 1 Here]. Patients who failed to be screened for HCV were more likely to be married (22.6% vs. 9.8%; p<0.01), have more education (35.7% vs. 26.5%; P=0.02), be cared for by private practice prenatal care providers (62.8% vs. 28.3%; p<0.01) and have a history of prescription opioid use (67.8% vs. 23.4%; p<0.01). Patients who were screened for HCV were more likely to have Medicaid insurance (97.6% vs. 89.4%; p<0.01), use methadone maintenance therapy (86.1% vs. 58.3%; p<0.01), have a history of heroin use (75.9% vs. 32.2%; p<0.01), use IV opioids (73.9% vs. 25.6%; p<0.01) and have a history of polysubstance use with cocaine (25.7% vs. 4.4%; P<0.01), benzodiazepines (30.0% vs. 15.2%; p<0.01) and marijuana (27.4% vs. 16.7%; p<0.01). Finally, patients with a psychiatric diagnosis (75.3% vs. 64.4%; p<0.01), a history of prostitution (6.6% vs. 1.1%; p<0.01), legal problems (33.1% vs. 7.2%; p<0.01), homelessness (5.1% vs. 0.6%; p<0.01), a history of abuse (24.2% vs. 13.3%; p<0.01), who had children who were no longer in their legal custody (33.1% vs. 11.1%; p<0.01) or who had a partner with a history of substance abuse (28.6% vs. 7.8%; p<0.01) were also more likely to be screened for HCV during pregnancy.

Multivariable analysis—Univariate and multivariate logistic regression models were developed to predict HCV screening [Table 2 Here]. Multicollinearity among substance use history and psychosocial risk factor variables was evaluated by comparing the VIF index. Among these variables, “IV” and “heroin” were found to be collinear (VIF > 3.5) while the VIF for all other variables was less than 1.5. Therefore, only “IV” was used in multivariable analyses. The variables “race” (p=0.77), “employment” (p=0.57) and “parity” (p=0.31) were also excluded from multivariate analyses due to p-values > 0.10 in univariate analyses. Finally, the variable “education” was excluded from multivariate analyses due to 26% missing data. Multivariate analyses were conducted with the remaining variables using stepwise logistic regression with backward elimination until the p-values of all predictors became less than 0.10. The model with the lowest BIC and AIC was designated as our final multivariable model.

Table 2 shows the multivariate model developed to predict HCV screening. Patients who were married (OR 0.52; 95% CI 0.29, 0.91), used buprenorphine maintenance treatment (OR 0.45; 95% CI 0.28, 0.71) and were cared for by private practice prenatal care providers (OR 0.29; 95% CI 0.19, 0.45) were significantly less likely to be screened for HCV infection. In contrast, patients who used benzodiazepines during pregnancy (OR 1.72; 95% CI 1.02-2.92), IV opioids (OR 6.15; 95% CI 3.96, 9.56), had legal problems (OR 2.23; 95% CI 1.12, 4.45), children not in their legal custody (OR 1.81; 95% CI 1.01, 3.24) and who had a partner with substance abuse history (OR 2.38; 95% CI 1.23, 4.59) were significantly more likely to receive HCV screening.

Model performance—Our final model had a BIC=638.34 and an AIC=591.85 and the area under the curve (AUC) was 0.86. A 10-fold cross-validation analysis was performed on the final model to calculate an average misclassification rate of 0.17 and an average AUC of

0.84. These values are very close to those of the final model, indicating that our model is generalizable and not overfitted.

Prenatal HCV evaluation and management

Among 611 pregnant women screened for HCV infection, 369 (60.4%) were HCV positive. The prenatal care laboratory evaluation and management patterns for the 369 HCV positive patients are described [Table 3 here]. Among these patients, 108 (29.3%) were diagnosed with HCV for the first time during pregnancy. ALT and AST were evaluated for 336 (91.1%) patients and 136 (40.5%) had an abnormal level during pregnancy. Approximately 25% of patients received HCV RNA or viral load testing, fewer than 17% had their HCV genotype evaluated and only 10% received a vaccination for Hepatitis A. We were unable to adequately determine the rate of immunity or need for immunization for Hepatitis B due to a lack of routine surface antibody testing performed during pregnancy at MWH. Importantly, although 285 (77.2%) patients were referred to hepatology, only 71 (24.9%) patients attended a consultation. Less than 2% of patients initiated HCV treatment within one year following delivery.

Because private practice prenatal care providers were less likely to screen for HCV infection, prenatal care laboratory evaluation and management patterns were also compared by provider type [Table 3 Here]. Patients who received prenatal care from the academic teaching service were significantly more likely to have their HCV infection diagnosed for the first time during pregnancy (32.8% vs. 20.9%; $p=0.02$), receive liver function testing during pregnancy (97.3% vs. 76.4%; $p<0.01$) and be referred to hepatology during pregnancy (85.3% vs. 58.2%; $p<0.01$) than patients who received prenatal care from a private practice provider.

DISCUSSION

This large study of prenatal screening and evaluation of HCV infection at a leading academic medical center found many missed opportunities to identify and evaluate women with OUD for HCV infection during pregnancy. Our results indicate that one-third of patients receive the diagnosis of HCV for the first time during pregnancy, emphasizing the importance of pregnancy as a critical period for HCV evaluation. In this evaluation, 77.2% of patients with OUD in our sample were screened for evidence of HCV infection which is lower than previously reported rates of HCV screening in high-risk populations during pregnancy, ranging from 85% to 98%.[7,19] Injection drug use is the most significant risk factor for HCV acquisition and in our sample, 25% of women with OUD who were not screened for HCV had a history of IV opioid use.

In multivariable analyses, private practice prenatal care providers were less likely to screen for HCV. In addition, among patients with HCV infection, private practice prenatal care providers were also less likely to evaluate liver function and refer patients to hepatology for treatment preparation during pregnancy. A discrepancy between rates of HCV screening and evaluation among private practice and academic teaching service providers indicates a need to intensify screening and evaluation for illicit drug use and associated comorbidities in private practice settings as the prevalence of illicit drug use among private practice patients

may also be underestimated during pregnancy. [20] Pregnant women with OUD on buprenorphine maintenance treatment were also less likely to be screened for HCV. While observational studies have demonstrated that women on buprenorphine maintenance treatment are more likely to have a history of oral prescription opioid use, HCV screening should be performed on all patients with a history of illicit opioid use.[21]

In patients with a diagnosis of HCV infection, over 90% had an evaluation of liver function performed at last once during pregnancy. Persistent elevations in ALT/AST values can be indicative of active liver disease, which develops in 60-70% of patients with chronic HCV infection.[21] In our study, ALT/AST values were found to be abnormal in approximately 40% of patients using the laboratory standards at UPMC (AST > 41 IU/L and ALT > 54 IU/L). In comparison, McNicholas et al. reported that 7.6% of participants in the NIDA-funded MOTHER trial had AST and ALT elevations that were three times the upper limit of normal (ALT=120; AST=105).[22] This discrepancy in our definitions of abnormal values resulted in the discrepancy between the prevalence of abnormal liver function tests found in our evaluations.

HCV RNA or HCV viral load testing accurately identifies patients with current infection and is recommended following a positive anti-HCV antibody test result.[21] Only 25% of patients in our sample had confirmatory HCV RNA testing. Low rates of HCV RNA testing have been also found in two previous evaluations of HCV antibody reactive pregnancies that reported HCV RNA testing rates of 16.4% and 18.1%.[7,19] Identification of HCV viral load is important due to the close correlation between maternal virema and vertical transmission.[8,12] While the lack of effective transmission prevention strategies may contribute to infrequent HCV RNA testing, an assessment of maternal viremia during pregnancy can assist with patient education and counseling regarding vertical transmission risk. Importantly, all infants born to anti-HCV antibody positive mothers, regardless of maternal viral load, require pediatric follow-up to evaluate for evidence of vertical transmission and subsequent infection.

HCV genotype testing is necessary for treatment planning and was evaluated for only 16% of patients. A low rate of genotype testing is not unexpected as treatment is currently contraindicated during pregnancy. However, due to an increase in engagement in health care services during pregnancy by substance-using populations, an evaluation of HCV genotype to prepare patients for treatment after delivery may be warranted for some patients.

Immunizations for Hepatitis A and B are recommended for patients who use illegal drugs especially those who share needles, syringes or other drug-injection equipment and patients with evidence of chronic liver disease.[21] Hepatitis B surface antibody testing was not routinely performed for patients in our sample to confirm immunization status. As a result, we were unable to adequately determine the rate of immunity or the need for immunization for Hepatitis B. However, only 10% of our sample received an immunization for Hepatitis A, which was only recently incorporated into routine vaccination schedules in 2010. Hepatitis A and B vaccines can be safely administered during pregnancy and should be considered in all patients with HCV infection without a previous history of immunization.[6]

Of significant clinical importance, our results indicate that less than 20% of patients referred to hepatology for counseling regarding disease course and treatment options actually attended a consultation. Furthermore, less than 2% of HCV infected patients had documented evidence of HCV treatment one year after delivery. Low rates of HCV-related health care utilization following delivery are consistent with previous evaluations. In an analysis of 159 HCV positive pregnancies, only 5.7% of patients were referred for a postpartum follow-up evaluation.[7] Failure to engage with hepatology and pursue postpartum treatment has serious long-term health implications. Women infected at a young age face a long duration of infection and therefore, an increased risk of disease progression and associated sequelae such as liver failure, hepatocellular carcinoma and transplantation. Moreover, women who fail to receive treatment for chronic HCV infection remain at risk for further disease transmission through needle sharing and vertical transmission in future pregnancies.

Inadequate prenatal evaluation of HCV infection may be due to limited provider knowledge of HCV risk factors, disease course and treatment options. In a systematic review of primary care provider (PCP) knowledge of HCV, many PCPs felt uncomfortable discussing risk factors for HCV with patients, incorrectly associated casual contact with transmission risk and less than 60% routinely offered immunization for hepatitis A and B.[23] Costs associated with laboratory evaluations outside of standard prenatal protocols may also prevent providers from further evaluating HCV disease status. Moreover, patient understanding of the risks of HCV and benefits of treatment are essential to engaging in care. Previous evaluations of non-pregnant, patients demonstrate frequent misinformation regarding HCV infection and treatment.[24] Fears related to sexual relationships and the possibility of transmission were common after HCV diagnosis and many patients received limited information from health care providers.[14,25,26] Patients often reported that they did not initiate HCV treatment due to either a lack of provider explanation and clarity regarding treatment options, insufficient provider encouragement to initiate treatment or generally poor relationships with providers. [27-29]

This study must be interpreted in light of certain limitations. This study sample represents the prenatal care practice patterns of providers in a large university-affiliated, tertiary care, teaching hospital and may not be generalizable to the practice patterns from providers in rural or community hospital settings. Moreover, the study sample represents a predominantly Caucasian population, consistent with demographic descriptions of opioid-using populations [30,31] and our results may not be generalizable to minority patients. In addition, our study is retrospective and the data is based on a review of available medical records, documentation by clinical providers and available laboratory data. All of the pregnant women in our cohort received their opioid maintenance therapy from either federally licensed methadone treatment facilities or nonobstetric, outpatient buprenorphine providers that do not share the same medical record system as providers in the UPMC system. Due to strict alcohol and drug treatment confidentiality requirements, the records from these providers were not available for review and may have contained additional data regarding HCV screening and evaluation. Retrospective data extraction may have also incompletely captured the rate of postpartum follow-up for HCV treatment, as patients may have presented to hepatologists outside of our health care system for consultation and HCV

treatment following delivery. Likewise, documentation regarding whether or not patients were previously aware of their diagnosis of HCV may be incomplete. Observational study designs are inherently vulnerable to selection bias and the possibility of residual confounding persists despite efforts to control for these factors in our analysis. Finally, the rate of HCV positivity in our sample may be underestimated as 22.8% of patients were not screened for HCV infection.

Our results emphasize the importance of pregnancy as a critical opportunity to identify and evaluate HCV infection in high-risk populations. Due to the lack of available interventions to prevent or decrease the risk of vertical transmission, optimal prenatal care practice patterns for the management of HCV infection in pregnancy have not been established and prenatal care approaches to HCV infection remain inconsistent and inadequate. Nevertheless, recent developments in interferon and ribavirin-free treatment regimens have dramatically changed the approach to HCV infection and have eliminated many of the previous barriers to treatment. Future research should be devoted to efforts to improve care coordination and inter-provider dialogue among substance abuse treatment providers, prenatal care providers and hepatologists to improve the efficiency and effectiveness of screening for common medical co-morbidities such as HCV infection as well as to the development of interventions designed to increase the number of patients enrolled in HCV treatment following delivery. As a new era in HCV treatment unfolds, prenatal care clinical recommendations and practice patterns must keep pace.

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Table 1

Characteristics of pregnant women with OUD who were and were not screened for HCV during pregnancy, n=791.[a]

	All n=791	HCV Screen n=611	No HCV Screen n=180	p-value
Demographics				
Age [years; mean (±SD)]	27.3 (±4.7)	27.1 (±4.7)	27.8 (±4.7)	0.09
Race				
Caucasian	760 (96.9)	589 (97.0)	171 (96.6)	0.77
Other	24 (3.1)	18 (3.0)	6 (3.4)	
Married	99 (12.7)	59 (9.8)	40 (22.6)	**<0.01**
Employed	134 (16.9)	101 (16.5)	33 (18.3)	0.57
Education				
≤HS/GED	384 (65.6)	312 (68.4)	72 (55.8)	**0.02**
Some college/Associates degree	167 (28.6)	121 (26.5)	46 (35.7)	
≥Bachelor's	34 (5.8)	23 (5.0)	11 (8.5)	
Medicaid	757 (95.7)	596 (97.6)	161 (89.4)	**<0.01**
Primaparous	271 (34.3)	215 (35.2)	56 (31.1)	0.31
Prenatal care provider				
Academic Teaching Service	505 (63.8)	438 (71.7)	67 (37.2)	**<0.01**
Private Practice	286 (36.2)	173 (28.3)	113 (62.8)	
Substance Use History[b]				
Opioid maintenance therapy				
Methadone	631 (79.8)	526 (86.1)	105 (58.3)	**<0.01**
Buprenorphine	160 (20.2)	85 (13.9)	75 (41.7)	
Tobacco use	659 (83.3)	517 (84.6)	142 (78.9)	0.07
Cocaine use	165 (20.9)	157 (25.7)	8 (4.4)	**<0.01**
Benzodiazepine use	209 (26.7)	182 (30.0)	27 (15.2)	**<0.01**
Marijuana use	197 (25.0)	167 (27.4)	30 (16.7)	**<0.01**
Opioid Type				
Heroin use	522 (66.0)	464 (75.9)	58 (32.2)	**<0.01**
Prescription opioid use	265 (33.5)	143 (23.4)	122 (67.8)	**<0.01**
Opioid Route				
Intravenous (IV) opioid use	498 (62.9)	452 (73.9)	46 (25.6)	**<0.01**
Psychosocial Risk Factors				
Maternal psychiatric diagnosis[c]	576 (72.8)	460 (75.3)	116 (64.4)	**<0.01**
Prostitution	42 (5.3)	40 (6.6)	2 (1.1)	**<0.01**
Legal problems[d]	215 (27.2)	202 (33.1)	13 (7.2)	**<0.01**
Homelessness	32 (4.1)	31 (5.1)	1 (0.6)	**<0.01**

	All n=791	HCV Screen n=611	No HCV Screen n=180	p-value
Abuse[e]	172 (21.7)	148 (24.2)	24 (13.3)	**<0.01**
Children not in maternal custody	221 (28.1)	201 (33.1)	20 (11.1)	**<0.01**
Partner with substance abuse history	189 (23.9)	175 (28.6)	14 (7.8)	**<0.01**

[a] n (%) unless otherwise indicated; less than 1.2% missing data for all variables except education with 26.0% missing data.

[b] Use at any time during pregnancy.

[c] Diagnosis by a physician at any time either before or during pregnancy.

[d] History of or current probation, arrest and/or incarceration.

[e] History of or current intimate partner violence or sexual abuse.

Table 2

Risk factors predictive of prenatal HCV screening for pregnant women with OUD, n=791.[a]

	Unadjusted OR (95% CI)	Adjusted OR[b] (95% CI)
Demographics		
Age (years)	0.97 (0.94, 1.00)	--
Race		
Caucasian	ref	--
Non-Caucasian	0.87 (0.34, 2.23)	--
Married	0.37 (0.24, 0.58)	**0.52 (0.29, 0.91)**
Employed	0.88 (0.57, 1.36)	--
Education		--
≤HS/GED	ref	--
Some college/Associates degree	0.61 (0.40, 0.93)	--
≥Bachelor's	0.48 (0.23, 1.03)	--
Medicaid	4.69 (2.33, 9.43)	2.06 (0.87, 4.87)
Primaparous	1.20 (0.84, 1.72)	--
Prenatal care provider		
Academic Teaching Service	ref	ref
Private Practice	0.23 (0.17, 0.33)	**0.29 (0.19, 0.45)**
Substance Use History[c]		
Opioid maintenance therapy		
Methadone	ref	ref
Buprenorphine	0.23 (0.16, 0.33)	**0.45 (0.28, 0.71)**
Tobacco use	1.47 (0.97, 2.24)	--
Cocaine use	7.45 (3.58, 15.49)	--
Benzodiazepine use	2.40 (1.54, 3.75)	**1.72 (1.02, 2.92)**
Marijuana use	1.88 (1.23, 2.89)	--
Opioid Type		
Heroin use	6.64 (4.62, 9.55)	--
Prescription opioid use	0.15 (0.10, 0.21)	--
Opioid Route		
Intravenous (IV) opioid use	8.28 (5.66, 12.12)	**6.15 (3.96, 9.56)**
Psychosocial Risk Factors		
Maternal psychiatric diagnosis[d]	1.68 (1.18, 2.40)	--
Prostitution	6.23 (1.50, 26.05)	--
Legal problems[e]	6.34 (3.52, 11.43)	**2.23 (1.12, 4.45)**
Homelessness	9.65 (1.31, 71.19)	--
Abuse[f]	2.08 (1.30, 3.32)	--

	Unadjusted OR (95% CI)	Adjusted OR[b] (95% CI)
Children not in maternal custody	3.95 (2.41, 6.48)	**1.81 (1.01, 3.24)**
Partner with substance abuse history	4.76 (2.68, 8.44)	**2.38 (1.23, 4.59)**

[a] OR=odds ratio; 95% CI=95% confidence interval.

[b] Values representative of the final multivariable model.

[c] Use at any time during pregnancy.

[d] Diagnosis by a physician at any time either before or during pregnancy.

[e] History of or current probation, arrest and/or incarceration.

[f] History of or current intimate partner violence or sexual abuse.

Table 3

Prenatal evaluation and management of OD pregnant women with HCV infection by provider type, n=369[a]

	All N=369	Academic Teaching Service N=259	Private Practice N=110	p-value
New HCV diagnosis during pregnancy	108 (29.3)	85 (32.8)	23 (20.9)	**0.02**
Laboratory testing received during pregnancy				
ALT/AST	336 (91.1)	252 (97.3)	84 (76.4)	**<0.01**
Abnormal	136 (40.5)	99 (39.3)	37 (44.1)	0.44
HCV RNA/viral load	94 (25.5)	70 (27.0)	24 (21.8)	0.29
HCV genotype	61 (16.5)	46 (17.8)	15 (13.6)	0.33
Immunizations received during pregnancy				
Hepatitis A vaccine	38 (10.4)	24 (9.4)	14 (12.7)	0.34
HCV treatment preparation				
History of treatment prior to pregnancy	11 (2.9)	7 (2.7)	4 (3.6)	0.63
Hepatology referral during pregnancy	285 (77.2)	221 (85.3)	64 (58.2)	**<0.01**
Attended hepatology referral[b]	71 (24.9)	56 (25.3)	15 (23.4)	0.76
Received postpartum treatment[b]	6 (1.6)	4 (1.5)	2 (1.8)	0.85

[a] n (%) unless otherwise indicated

[b] within one year postpartum