Using the electronic medical record to increase testing for HIV and hepatitis C virus in an Appalachian emergency department

Carmen N. Burrell DO1,2, Melinda J. Sharon MPH1, Stephen Davis PhD1,5, Judith Feinberg MD3,4, Elena M. Wojcik MPH1, Julia Nist6, Owen Lander MD1, Valerie Boley RN7, Justin Burns1, Ian B.K. Martin MD MBA8

1Department of Emergency Medicine, West Virginia University School of Medicine, Morgantown, West Virginia, United States
2Department of Family Medicine, West Virginia University School of Medicine, Morgantown, West Virginia, United States
3Department of Behavioral Medicine and Psychiatry, West Virginia University School of Medicine, Morgantown, West Virginia, United States
4Department of Medicine, Division of Infectious Diseases, West Virginia University School of Medicine, Morgantown, West Virginia, United States
5Department Of Health Policy, Management, and Leadership, West Virginia University School of Public Health, Morgantown, West Virginia, United States
6West Virginia University Medicine, Information Technology, Morgantown, West Virginia, United States
7West Virginia University Medicine, Emergency Service, JW Ruby Memorial Hospital, Morgantown, West Virginia
8Department of Emergency Medicine, Medical College of Wisconsin, Milwaukee, Wisconsin, United States

Corresponding Author:
Carmen N. Burrell, DO
West Virginia University, School of Medicine
1 Medical Center Drive
Morgantown, WV, 26506
Email: cburrell@hsc.wvu.edu
Telephone: 304-293-2436

Running Title: Using the electronic medical record to test for HIV and Hepatitis C Virus in an Appalachian emergency department
ABSTRACT

Background: The ongoing Appalachian opioid epidemic has led to increasing hepatitis C virus (HCV) infections among people who inject drugs (PWID), and Human Immunodeficiency Virus (HIV) outbreaks have been observed. The primary objective of this study was to use the electronic medical record (EMR) to increase HIV and HCV testing in a central Appalachian academic emergency department. A secondary objective was to increase linkage to care using patient navigators.

Methods: EMR algorithms based on current Centers for Disease Control and Prevention HIV and HCV testing recommendations were created that triggered Best Practice Alerts (BPAs), giving providers a one-click acceptance option to order HIV and/or HCV testing. Placards were placed in care areas, informing patients of the availability of routine screening. Patient navigators facilitated linkage to care for seropositive patients.

Results: The BPA appeared 58,936 times on 21,098 patients eligible for HIV screening and 24,319 times on 11,989 patients eligible for HCV screening over a one-year period. Of those, 7,106 (33.7%) patients were screened for HIV and 3,496 (29.2%) patients were screened for HCV, for an overall testing increase of 2,269% and 1,065% for HIV and HCV, respectively. Linkage to care increased by 15% for HIV to 100%, and 14% for HCV to 64%.

Conclusion: HIV and HCV screening and linkage to care were increased in an academic ED setting in central Appalachia using EMR alerts. This approach could be utilized in multiple ambulatory settings. Increased testing and earlier linkage to care may help combat the current injection drug use-related HCV epidemic and avoid additional HIV outbreaks.

INTRODUCTION

Background
From 2003-2010, 3.5 million persons (range 2.5-4.7 million) were estimated to be infected with hepatitis C virus (HCV) in the United States.[1] HCV is a leading cause of advanced liver disease, and treatment of HCV-related diseases, including cirrhosis and hepatocellular carcinoma, is estimated to cost $6.5 billion per year.[2,3] Injection drug use (IDU) is the primary driver of HCV infection and accounts for 60 to 70% of incident cases in the U.S. and other countries.[4,5] The Appalachian region is currently in the midst of an injection opioid epidemic that is directly correlated with an HCV syndemic. Between 2006 and 2012, central Appalachia (Kentucky, Tennessee, Virginia and West Virginia) observed a 364% increase in acute HCV cases.[6] During this same time period, admissions to treatment for opioid use disorder in these states increased from 8.6% to 12%.[6] IDU is also a risk factor for HIV acquisition, and recently, HIV outbreaks among people who inject drugs (PWID) in West Virginia have been identified in Huntington and Charleston.[7,8]

**Importance**

It is estimated that 45%-85% of individuals are unaware of their HCV seropositivity.[5] Additionally, HCV co-infection with HIV has been observed at rates greater than 90% in HIV-positive persons who inject drugs (PWID).[9] The Centers for Disease Control and Prevention (CDC) has recommended HCV risk-based (e.g., injection drug use) screening since 1998, and in 2012 added a one-time HCV test recommendation for individuals born between 1945 and 1965, generally referred to as the “baby boomer” cohort, based on an observed 3.25% HCV prevalence in this cohort.[10]

Traditionally, screening for infectious diseases in the emergency department (ED) has been driven by presenting complaint (e.g., fever, occupational bloodborne exposures, etc.) and clinical suspicion. Research has shown that this approach consistently misses cases, which
supports the need for regular, non-clinically driven screening.[11] However, routine opt-out screening for HIV and HCV in this setting is often challenged by provider concerns over screening time, the time needed to link patients with positive results to care, and legal issues related to screening.[12] Consequently, physician-initiated testing in the ED has resulted in around 1% of patients being screened for HIV in the U.S.[12]

**Goals of This Investigation**

Gilead Sciences, Inc. established the Frontlines of Communities in the United States (FOCUS) program to promote routine, scaled-up screening (antibody plus confirmatory Ribonucleic Acid [RNA]) for HIV and HCV in the clinical setting.[13] A central component of the FOCUS program is the use of the electronic medical record (EMR) to assist in scaled-up testing. The FOCUS program TEST model contains four principles for routine screening: 1) testing integrated into normal clinical flow; 2) electronic medical record modification to support screening; 3) systemic policy change; and, 4) training, feedback, and quality improvement.[13] Previous studies have successfully used the EMR to increase screening for HIV and other infectious diseases.[14-19] However, all were conducted in urban areas not currently in the midst of a burgeoning opioid epidemic like the current one affecting central Appalachia.

We conducted a study based on the TEST model with support from Gilead Sciences, Inc., to increase screening for HIV and HCV in an academic central Appalachian emergency department (ED) through the use of Best Practice Alerts (BPAs), a clinical decision tool triggered during patient visits for those eligible to receive only HIV screening, only HCV screening, or screening for both HIV and HCV according to CDC criteria.

**METHODS**

**Study Design and Setting**
Through the TEST model, an EMR-based protocol was implemented for routine HIV and HCV screening in a Level I trauma, tertiary care, academic medical center’s ED located in West Virginia. This ED has approximately 50,000 visits per year, with an average door to disposition time of 3.0 hours for discharged patients. HIV screening was based on CDC guidelines to test individuals between ages 13 to 64 years at least once and high-risk individuals at least yearly.[20] However, due to the requirement of parental consent for pediatric patients, the site protocol was adjusted for testing to be performed on patients 18 to 94 years of age, both eliminating the need for patient consent for minors and to capture adults who may have not been previously tested. HCV testing was based on CDC guidelines, testing all individuals born from 1945 through 1965, those with a recognized exposure, or those who are recognized as high-risk.[21] FOCUS-supported studies define linkage to care as a first appointment with a provider within 3 months of testing.

**The Electronic Medical Record**

To promote increased HIV and HCV screening within the TEST model, we designed BPAs in our EMR (Epic® 2015, Epic Systems Corporation) based on CDC guidelines for HIV (Figure 1) and HCV testing (Figure 2) adjusted for age as described above. If the EMR found the patients eligible based on age cohort and/or risk factors, the BPA would be triggered and appear to providers and staff upon opening the orders tab. After approval by the hospital clinical decision support team responsible for all BPA requests, an Epic® ED module analyst expended roughly 20 hours of time building and testing the BPA algorithm. Upon presentation of the BPA, providers and nursing staff could select from the following options if they decided to not order screening: “Will Assess,” “Not Clinically Appropriate,” and “Patient Refused.”[22] When providers chose “Will Assess,” the BPA would continue to appear until orders were placed or
another option was chosen; however, a hard stop was not employed and charts could be closed without an acceptance or rejection of the order.

**Provider Training**

Attending and resident physicians, advanced practice providers (APPs), and nursing staff were instructed on both the BPAs and the screening eligibility criteria to prepare for implementation. A live training session was conducted with all providers at a regularly scheduled staff meeting, per the TEST principle that encourages training, feedback and quality improvement. Thereafter, brief monthly program updates were provided at these meetings, allowing for opportunities for clinician feedback. Additionally, frequent electronic reminders with protocol details and BPA screenshots were sent from physician and nursing leadership to all providers and staff. These trainings and educational efforts were vital, given the fact that few alerts appeared within the EMR environment prior to this initiative.

**Implementation of Screenings**

The BPA-triggered HIV and HCV screening was implemented in June 2017. To facilitate testing, the BPA was configured, by risk factors and age, to trigger at multiple points in the patient care process, such as during nursing triage and provider evaluation. The BPA required only one “mouse click” for the provider to order each screening test. Placards were hung in all treatment and triage areas to inform patients. The provider or nursing staff would also inform the patient of any planned screenings, and, in turn, the patient would have the opportunity to opt out of screening for HIV and/or HCV at time of evaluation (Figures 1 and 2). If a patient did not express the desire to opt out, HIV/HCV testing was conducted on the same blood drawn for routine initial tests. This procedure obviated the need to draw an additional serum sample later during the visit. The patient would also have the opportunity for testing if no laboratory testing
work was planned, and the provider would have the opportunity to defer testing if not clinically appropriate or the patient refused.

**Figure 1.** HIV screening and linkage to treatment testing algorithm utilized.

**Figure 2.** HCV screening and linkage to treatment testing algorithm utilized.

**Laboratory Testing**

The HIV screening test utilized by the hospital laboratory is a fourth-generation combined antigen and antibody chemiluminescent immunoassay test that reflexes automatically to an antibody differentiation immunoassay for confirmation. Nucleic acid testing is performed at the provider's discretion for patients deemed at higher risk for acute infection (Figure 1). The HCV screening test utilized is a chemiluminescent microparticle immunoassay performed on the ARCHITECTi® platform that reflexes automatically to quantitative HCV RNA testing, if the initial antibody test result is positive (Figure 2). HIV confirmatory results were available for viewing within twelve hours, and HCV RNA results were available within three days although initial antibody tests could be available within a few hours. All tests are completed in real time. All HIV and HCV antibody and confirmatory tests were free of charge through grant funding from the FOCUS program.

**Patient Navigators and Linkage to Care**

Upon a positive screening result, a member of the patient’s care team initially notified the patient of his/her antibody results if the patient was still in the ED, and when available, patient navigators (PNs) would also meet with the patient in the ED to assist with linkage to care. Patients that screened positive and were dispositioned elsewhere were initially contacted by the PNs. PNs built rapport with patients and informed them that all their questions would be answered at the time of their appointment with the referred specialty provider. PNs were trained
by clinical faculty and staff of the Department of Emergency Medicine at the West Virginia University School of Medicine and were also Health Insurance Portability and Accountability Act (HIPPA) compliant. PNs were responsible for linkage to care only for FOCUS program participants.

Follow-up appointments were scheduled with infectious diseases (ID), behavioral medicine, digestive diseases, gastroenterology, or primary care, which were all considered appropriate linkage to care. PNs called patients to discuss patient awareness of test result(s) and available appointment options. If a patient screened antibody positive for HIV or HCV during daytime hours, the PNs met with the patients in the ED to inform them of their antibody results and that someone would be in touch via telephone to give confirmatory results and provide linkage to care in the next few days. PNs worked closely with schedulers in each department in order to expedite follow-up appointments or re-testing when necessary. When following up with patients after initial contact, PNs gave patients the opportunity to choose texting as the main form of contact, as opposed to future phone calls. This was the first FOCUS program to offer a texting option for the primary form of communication.

Patients who screened HIV-positive and had a subsequent positive confirmatory result were referred to the West Virginia University Positive Health Clinic for immediate follow-up and further evaluation. The Positive Health Clinic, supported in part by the Ryan White Care Act, provides state-of-the-art, comprehensive HIV care services to a largely rural, medically-underserved area where access to HIV care is very limited. Patients who initially screened positive for HIV but had a negative or indeterminate confirmatory result were contacted by the PNs and encouraged to have repeat HIV testing in 6 weeks, due to the potential risk of early
infection. When possible, these patients were scheduled to return to one of our primary or urgent care locations for testing, instead of an additional ED visit.

Patients were contacted by PNs and subsequently referred for HCV follow-up appointments with the (ID), digestive diseases, behavioral medicine, or primary care clinic upon an initial positive antibody screening result regardless of confirmatory testing status. This was due to the risk of a previously active infection or potential of having risk factors requiring follow-up. Most patients were seen by ID; however, other clinic referrals, such as digestive diseases clinic, were made based on patient preference or could be deferred if the patient had previously scheduled primary care or behavioral medicine appointments. All patients who had previously scheduled appointments with primary care or behavioral medicine were also contacted by PNs so that HCV status would be known. Patients were asked to inform the provider of their status at the time of their scheduled appointment so that the provider could refer the patient to follow-up care.

Patients who were not successfully linked to care within 90 days were considered to be “lost to follow-up” and were not contacted again by PNs. Patients could be linked to care after 90 days if they reached out to PNs via call or text to the PN. However, there are a small percentage of patients who are considered to be “lost to follow-up” before the 90-day period; reasons for this included incarceration, death, and being uninterested in attending an appointment. Although PNs stressed the importance of attending an appointment, patients who were uninterested were asked to reach out to the PN if a different decision was made after consideration.

In order to enhance patient follow-up, PNs offered transportation assistance to patients to decrease that barrier to linkage to care. PNs could coordinate taxi transport with patients who did not have their own means of transportation, offer gas gift cards to those who had a reliable
source of transportation but needed help affording the trip, or provide information on local bus transit routes close to their residence. In addition, PNs also offered to accompany patients to their first appointment.

**Data Analysis**

The following data points were tracked: number of BPA appearances per patient for HIV and HCV, number of HIV and HCV screening orders and patients tested, positive screening and confirmatory results for HIV, antibody-positive and RNA-positive results for HCV, age, gender, race, history of IDU, and number of patients successfully linked to care within three months. Demographics and risk factors were obtained based on real-time chart reviews for each patient with a positive screening test and results from the EMR were entered into a log by the PNs. All data points were analyzed descriptively to provide percentages and appearance rates for the BPA.

**RESULTS**

Prior to implementation, approximately 300 HIV screenings and 300 HCV screenings were conducted in the ED between July 2015 and July 2016, and only 85% and 50% respectively of those with positive results were linked to care as a result of testing. From June 5, 2017 to May 31, 2018, 29,684 adult patients presented to the ED. The BPA appeared 58,936 times on 21,098 patients eligible for HIV screening, for a rate of 2.8 times per patient. The BPA appeared approximately 24,319 times on 11,989 patients eligible for HCV screening, for a rate of 2.0 times per patient. Of those eligible, 7,106 (34%) patients agreed to be screened for HIV and 3,496 (29%) patients for HCV (Figure 3), which is a 2,269% and 1,065% increase in HIV and HCV screening, respectively, in 12 months.

**Figure 3.** HIV and HCV screening statistics and linkage to treatment rates. *172/268.
Of the 322 HCV positive patients, 54 were excluded from the linkage to treatment rate for the following reasons: 35 patients were scheduled for an appointment further in the future, 15 patients were incarcerated, and four patients were deceased.

Twenty-eight patients screened HIV-positive and 15 (53.6%) had positive confirmatory results; of those, only one was newly diagnosed. The average age of HIV-positive patients was 39 years (range 19 to 62 years); the majority were male (60%), white (60%), and non-Hispanic (80%). According to chart review, three of 15 (20%) stated their method of acquisition was related to IDU (Table 1), and all were linked to care through the Positive Health Clinic (100%). The remaining 13 patients had negative or indeterminate HIV confirmatory results; all were scheduled for additional testing and were subsequently determined to not have HIV infection.

Table 1. HIV and HCV-positive patient demographics

|                      | HIV N (%) | HCV N (%) |
|----------------------|-----------|-----------|
|                      | Total N = 28 | Total N = 322 |
| Gender               |           |           |
| Male                 | 17 (60)   | 183 (57)  |
| Female               | 11 (40)   | 139 (43)  |
| Age                  |           |           |
| Range                | 19 – 62   | 20 – 76   |
| Average              | 39        | 43        |
| Race                 |           |           |
| White                | 17 (60)   | 290 (90)  |
| Other                | 11 (40)   | 32 (10)   |
| Ethnicity            |           |           |
| Non-Hispanic         | 23 (80)   | 312 (97)  |
| Hispanic             | 5 (20)    | 10 (3)    |
| IDU                  |           |           |
| Yes                  | 3 (20)    | 235 (73)  |
| No                   | 25 (80)   | 87 (27)   |
| “Baby Boomer”        |           |           |
| Yes                  | N/A       | 117 (36)  |
| No                   | N/A       | 205 (64)  |
| MSM                  |           |           |
| Yes                  | 7 (25)    | N/A       |
| No                   | 21 (75)   | N/A       |
Overall, 322 patients screened antibody-positive for HCV, with 191 (59%) having a positive RNA confirmatory result; of the confirmed positive results, 141 (74%) were newly identified. The average age of HCV antibody-positive patients was outside the risk factor group of the “baby boomer” cohort at 43 years (range 20 to 76 years); the majority were male (57%), white (90%), and non-Hispanic (97%). Following extensive chart review, 73% were found to have a history of IDU (Table 1). All 322 patients with antibody-positive HCV results were referred to the infectious diseases and/or digestive diseases clinics for follow-up. The PNs were able to link 172 of 268 eligible patients (64%) to their first follow-up appointment within 3 months, with 35 (13%) having a future scheduled appointment, 15 (6%) incarcerated, and four (1%) deceased (Figure 3). Five patients were co-infected with HIV and HCV. Although only seven gas gift cards were provided to facilitate linkage to care, all seven patients successfully attended their first appointment.

**DISCUSSION**

Our study is the first to highlight the challenges and successes of implementing HIV and HCV EMR-based screening in an ED serving rural, central Appalachia using the TEST model. Using an EMR to prompt providers to order HIV and HCV screening based on CDC guidelines that were age-adjusted was highly successful in increasing screening rates for both infections; it also showed that testing outside of the ages recommended by CDC guidelines established a high

| Heterosexual Contact | Yes | N/A |
|----------------------|-----|-----|
|                      | 6 (21) | N/A |
|                      | 22 (79) | N/A |

| Confirmed Positive | Yes | N/A |
|--------------------|-----|-----|
|                    | 15 (54) | 191 (59) |
|                    | 13 (46) | 131 (41) |

*IDU- injection drug user; Baby Boomer- person born between 1945 and 1965; MSM- men who have sex with men
number of positives. An increase in linkage to care rates for both HIV and HCV seropositive individuals with the use of PNs was observed, and this was the first FOCUS program to successfully utilize texting as the primary mode of communication to assist in linkage to care.

Previous studies have implemented similar EMR-based infectious diseases screenings in the ED; however, these studies were conducted entirely within urban areas. When compared to our urban ED counterparts, our patient population screening antibody-positive for HCV was slightly lower in age on average than the established “baby boomer” cohort for whom testing is recommended.

By using EMR-programmed, reflex testing for antibody-positive patients in our hospital laboratory, we were able to achieve a 100% HCV RNA confirmatory testing rate. This is significantly higher than the 40-50% HCV RNA testing rate described in the literature.

Furthermore, our BPA required fewer “mouse clicks” (two total) for the provider to order both screening tests than prior studies. The ease of ordering an HIV and/or HCV test in the ED may have resulted in an increased order rate. Configuring the BPA to trigger at multiple points in the patient care process (i.e., triage, in-room, etc.) also likely promoted increased screening rates.

Most impressively, our linkage to care rates of 64% (HCV) and 100% (HIV) are among some of the highest reported, which has typically been shown to vary between 30-40% for HCV and 60-80% for HIV seropositive patients, respectively. Our rates may be higher than prior studies for a number of reasons. First, PNs were able to contact patients via texting per patient preference, and texting as a means of contacting patients—particularly younger patients—has been suggested as a successful strategy for hard-to-reach patients such as PWID and is novel to our FOCUS study.

A recent study among PWID in San Diego observed that the majority used mobile technology for voice, text and/or internet access, with high mobile
technology use associated with younger age.[23] Other studies have noted that accompanying patients to their appointment increases the patient’s likelihood of attending.[14] Offering this service to the patient population may have assisted with increasing the linkage to care rates as well.

Second, our PNs worked closely with the schedulers within multiple specialty clinics to ensure patients were scheduled within 2-4 weeks of their original ED visit, well within the FOCUS program requirement for a first visit to be scheduled within 3 months. Keeping the follow-up appointment as close to the original ED visit date as possible maintained a recency effect, reminding patients of the importance of attending their scheduled appointments. PNs contacted patients soon after their ED visit to convey confirmatory results and to schedule referral to a specialist shortly thereafter. Third, since transportation can be a significant problem in rural areas, providing transportation assistance promoted attendance at follow-up appointments. Lastly, as our ED is part of a large healthcare system in central Appalachia, a breadth of follow-up referral options were available for successful linkage to care. Keeping patients connected through the extensive healthcare system likely increased the chances of linkage to care, as has been noted by similar studies.[14]

Implementation Challenges

Success notwithstanding, we faced a few notable challenges. First, during the initial two weeks of implementation, the BPA was scheduled to appear upon the provider and nursing staff entering the patient’s chart at any time. This design led to an increased rate of inappropriate BPA appearances. More specifically, providers often felt they did not have sufficient information about patients to address the BPA upon initially entering the patient’s chart at the beginning of the patient visit. The BPA would continue to trigger until an option was chosen and the chart was
closed; the BPA would also inappropriately trigger during order encounters or addendum to patient visits. As a result of this feedback, we moved the location of the BPA to occur upon opening the orders tab of the patient’s chart; this was the preferred location by our providers and proved to be the most logical option during the course of care. If no orders were placed, the BPA would not be triggered.

Second, the EMR was programmed to appear based on specified risk factors as outlined by the CDC and modified based on age.[20-22] For the BPA to trigger, specified risk factors must be populated in searchable areas of the EMR— for example, the problem list or past medical history tabs. However, we discovered during the study that these tabs— and other searchable areas of the EMR— are often not populated with the most up to date patient information. Similar findings regarding risk-based screenings via the EMR have been reported.[20] Another aspect of the BPA’s initial programming was for the BPA to appear upon certain chief complaints assigned to the patient during nursing staff triage procedures. Initially, the BPA would not be triggered for the physician or APP if the nursing staff had dismissed the alert. Based upon provider feedback, the algorithm was modified to trigger the BPA in the orders section of a provider chart even if a nurse initially selected “Not Clinically Appropriate” or “Patient Refused” at triage. This modification gave providers the option of assessing whether or not testing was indicated by further clinical information gathered during the course of evaluation and provided additional patient education opportunities regarding screening benefits. If the patient is questioned about personal history of IDU or other risky behaviors, it is difficult to determine if they will feel comfortable to give open and honest responses to the physician, making it a difficult process to navigate. One study found that over 80% of participants reported having ever avoided telling a clinician medically relevant information.[24] Failure to disclose
information can decrease patient care, and even lead to patient harm.[24] Therefore, future strategies to update this risk information, as well as the triage complaint, captured in the EMR during the patient visit are being explored to maximize the identification of patients for whom CDC recommended screening is indicated.

Although our PNs were some of the most successful in the FOCUS program to link patients to care, this success also came with its challenges. PNs frequently could not connect with patients on the first attempt due to a lack of contact information for the patients available in the patient’s chart. If patients did not provide sufficient or accurate contact information upon presentation to the ED, the PNs could not follow-up in a timely manner, if at all. We recommend future studies examine the addition of registration personnel to the navigation team to ensure that patients are providing multiple, accurate points of contact, so that PNs can ensure successful follow-up and linkage to care.

**Future Directions**

We are currently in the process of deploying the HIV/HCV testing BPA in an additional hospital ED that recently adopted Epic® and are exploring the feasibility of deploying these BPA alerts in other hospital EDs throughout our healthcare system as they implement Epic®. We are in the process of implementing universal screening for HCV driven by age criteria to address the difficulties encountered with configuring the BPA to trigger based on unavailable risk factors. Finally, we are examining testing rates by provider and investigating observed ordering discrepancies to further maximize our screening rates.

**LIMITATIONS**

Our study is based on implementation at a single site. Second, the largest limitation is the omission of documented critical information in the EMR. While the goal was to follow CDC
testing guidelines for patient risk factors, these risk factors are not always present in a readily accessible format in the EMR. This results in a gap in which eligible patients go untested, and their HIV and/or HCV status remains unknown. While the EMR was able to query data from the patient’s problem list, past medical history, and diagnosis at time of visit to identify eligibility for testing, this information is often missing or inaccurate, or it may be documented in other segments of the medical record such as the history narrative. We hoped that by adjusting screening criteria based on age, we would capture this missing population. Risk factors frequently remain unknown if not discussed at the time of visit or if the patient fails to disclose key information such as IDU. Lastly, the PNs frequently encountered the obstacle of incorrect or missing patient contact information and therefore could not link patients to care or further follow-up testing when needed.

CONCLUSION

Our study has demonstrated the feasibility and initial success of introducing an EMR-based HIV and HCV screening program based on CDC screening guidelines modified by age into an academic, Appalachian ED using the TEST model. Increased identification of positive cases resulting from EMR-stimulated increased testing may help identify persons with HCV for curative therapy, while helping prevent an HIV outbreak due to the substantial regional increase in IDU. Future studies should examine the impact of modifying EMRs to better capture risk-based information on testing rates pre- and post-implementation of an EMR-based intervention. Strategies to promote the capture of accurate contact information for the hard-to-reach PWID population and improved linkage to care rates for patients testing positive for HIV and/or HCV are also needed.

DECLARATIONS
Ethics Approval and Consent to Participate

The West Virginia University Institutional Review Board approved the protocol (IRB#1702458862) as non-human subject research.

Consent for Publication

Not applicable

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are not publicly available due to IRB restrictions to protect sensitive information.

Competing Interests

The authors have no competing interests.

Funding

This study was supported by Gilead Sciences’ Frontlines of Communities in the United States (FOCUS), contact number 416027.1.

Authors’ Contributions

CB and MS - drafted the manuscript and provided editing for submission.

SD – drafted the manuscript, provided edits, completed data review and analysis and assisted with submission.

JF, OL, VB – Contributed to manuscript review and editing.

EW – Contributed to data collection, editing and submission.

JN, JB – Contributed to data collection.

IM – Contributed to manuscript supervision, assisted with drafting the manuscript and provided critically important intellectual content during manuscript revisions.
All authors read and approved the final manuscript, and take public responsibility for their contributions to the manuscript.

Acknowledgements

The authors would like to thank Haleigh Hughes for her contributions with submission of the manuscript as well as Kimberly Quedado PhD for her assistance with manuscript review and submission.

Authors’ Information (Optional)

REFERENCES

1. Edlin BR, Eckhardt BJ, Shu MA, Holmberg SD, Swan T. Toward a more accurate estimate of the prevalence of hepatitis C in the United States. Hepatology. 2015 Nov;62(5):1353-63.

2. Cooke GS, Lemoine M, Thursz M, Gore C, Swan T, Kamarutzaman A, DuCros P, Ford N. Viral hepatitis and the Global Burden of Disease: a need to regroup. J Viral Hepat. 2013;20(9):600-601.

3. Razavi H, ElKhoury AC, Elbasha E, Estes C, Pasini K, Poynard T, Kumar R. Chronic hepatitis C virus (HCV) disease burden and cost in the United States. Hepatology. 2013 Jun;57(6):2164-2170.

4. Keeshin SW, & Feinberg J. Endocarditis as a Marker for New Epidemics of Injection Drug Use. Am J Med Sci. 2016 Dec;352(6):609-614.

5. Ward JW. The hidden epidemic of hepatitis C virus infection in the United States: occult transmission and burden of disease. Top Antivir Med. 2013 Feb-Mar; 21(1): 15-9.

6. Zibbell JE, Iqbal K, Patel RC, Suryaprasad A, Sanders KJ, Moore-Moravian L, Serrecchia J, Blankenship S, Ward JW, Holtzman D. Increases in hepatitis C virus infection related to injection drug use among persons aged <=30 years - Kentucky, Tennessee, Virginia, and
West Virginia, 2006-2012. *MMWR Morbidity and mortality weekly report.* 2015 May;64(17):453-8.

7. West Virginia Department of Health and Human Resources, Bureau for Public Health. *Health advisory No. 155: increase in new HIV infections among persons who inject drugs.* https://oeps.wv.gov/healthalerts/documents/wv/WVHAN_155.pdf. Published March 22, 2019. Accessed January 8, 2020.

8. West Virginia Department of Health and Human Resources, Bureau for Public Health. *Health advisory No. 162: Human immunodeficiency virus (HIV) infections among persons who inject drugs—additional area seeing increase, others vulnerable.* https://oeps.wv.gov/healthalerts/documents/wv/WVHAN_162.pdf. Published October 9, 2019. Accessed January 8, 2020.

9. Taylor LE, Swan T, Mayer KH. HIV coinfection with hepatitis C virus: evolving epidemiology and treatment paradigms. *Clin Infect Dis.* 2012 Jul;55 Suppl 1:S33-42.

10. Smith BD, Morgan RL, Beckett GA, Falck-Ytter Y, Holtzman D, Teo C, Jewett A, Baack B, Rein DB, Patel N, Alter M, Yartel A, Ward JW. Recommendations for the identification of chronic hepatitis C virus infection among persons born during 1945-1965. *MMWR Morbidity and mortality weekly report.* 2012;61(Rr-4):1-32.

11. Prekker ME, Gary BM, Patel R, Olives T, Driver B, Dunlop SJ, Miner JR, Gordon S, Schut R, Gray RO. A comparison of routine, opt-out HIV screening with the expected yield from physician-directed HIV testing in the ED. *Am J Emerg Med.* 2015 Apr;33(4):506-11.

12. De Rossi N, Dattner N, Cavassini M, Peters S, Hugli O, Darling KEA. Patient and doctor perspectives on HIV screening in the emergency department: A prospective cross-sectional study. *PLoS One.* 2017 Jul 21;12(7):e0180389.
13. Sciences G. Gilead’s FOCUS Program: Increasing Routine HIV and HCV Screening and Linkage to Care. 2017. http://www.gilead.com/~/media/files/pdfs/other/hiv-focus-program.pdf?la=en.

14. Coyle C, & Kwakwa H. Dual-Routine HCV/HIV Testing: Seroprevalence and Linkage to Care in Four Community Health Centers in Philadelphia, Pennsylvania. Public Health Rep. 2016 Jan-Feb; 131 Suppl 1:41-52.

15. Coyle C, Kwakwa H, Viner K. Integrating Routine HCV Testing in Primary Care: Lessons Learned from Five Federally Qualified Health Centers in Philadelphia, Pennsylvania, 2012-2014. Public Health Rep. 2016 May-Jun; 131 Suppl 2:65-73.

16. Coyle C, Viner K, Hughes E, Kwakwa H, Zibbell JE, Vellozzi C, Holtzman D. Identification and Linkage to Care of HCV-Infected Persons in Five Health Centers - Philadelphia, Pennsylvania, 2012-2014. MMWR Morbidity and mortality weekly report. 2015;64(17):459-463.

17. Crumby NS, Arrezola E, Brown EH, Brazzeal A, Sanchez TH. Experiences Implementing a Routine HIV Screening Program in Two Federally Qualified Health Centers in the Southern United States. Public Health Rep. 2016 Jan-Feb; 131(Suppl 1): 21–29.

18. Lin J, Baghikar S, Mauntel-Medici C, Heinert S, Patel D. Patient and System Factors Related to Missed Opportunities for Screening in an Electronic Medical Record-driven, Opt-out HIV Screening Program in the Emergency Department. Acad Emerg Med. 2017 Nov;24(11):1358-68.

19. Lin J, Mauntel-Medici C, Heinert S, Baghikar S. Harnessing the Power of the Electronic Medical Record to Facilitate an Opt-Out HIV Screening Program in an Urban Academic Emergency Department. J Public Health Manag Pract. 2017 May/Jun;23(3):264-268.
20. Centers for Disease Control and Prevention. HIV/AIDS: Laboratory tests. Accessed January 1, 2019. Available at: https://www.cdc.gov/hiv/testing/laboratorytests.html.

21. Centers for Disease Control and Prevention. Viral hepatitis: Testing recommendations for hepatitis C virus infection. Accessed January 1, 2019. Available at: https://www.cdc.gov/hepatitis/hcv/guidelinesc.htm.

22. Burrell CN, Sharon MJ, Davis SM, Wojcik EM, Martin IBK. Implementation of a collaborative HIV and hepatitis C screening program in Appalachian urgent care settings. *West J Emerg Med*. 2018 Nov;19(6):1057-1064.

23. Collins KM, Armenta RF, Cuevas-Mota J, Liu L, Strathdee SA, Garfein RS. Factors associated with patterns of mobile technology use among persons who inject drugs. *Subst Abus*. 2016 Oct-Dec;37(4):606-612. Epub 2016 Apr 19.

24. Levy AG, Scherer AM, Zikmund-Fisher BJ, Larkin K, Barnes GD, Fagerlin A. Prevalence of and factors associated with patient nondisclosure of medically relevant information to clinicians. *JAMA Netw Open*. 2018 Nov:30(7):e185293.doi:10.1001/jamanetworkopen.2018.5293.
Figure 1. HIV screening and linkage to treatment testing algorithm utilized.
Figure 2. HCV screening and linkage to treatment testing algorithm utilized.
**Figure 3.** HIV and HCV screening statistics and linkage to treatment rates.