Comparison of Risk-Based Hepatitis C Screening and the True Seroprevalence in an Urban Prison System

Danica E. Kuncio, E. Claire Newbern,
Marcelo H. Fernandez-Viña, Bruce Herdman,
Caroline C. Johnson, and Kendra M. Viner

ABSTRACT *Hepatitis C virus (HCV) is the most common blood-borne infection in the USA, though seroprevalence is elevated in certain high-risk groups such as inmates. Correctional facility screening protocols vary from universal testing to opt-in risk-based testing. This project assessed the success of a risk-based HCV screening strategy in the Philadelphia Prison System (PPS) by comparing results from current testing practices during 2011–2012 (Risk-Based Screening Group) to a September 2012 blinded seroprevalence study (Philadelphia Department of Public Health (PDPH) Study Cohort). PPS processed 51,562 inmates in 2011–2012; 2,727 were identified as high-risk and screened for HCV, of whom 57 % tested HCV antibody positive. Twelve percent ($n=154$) of the 1,289 inmates in the PDPH Study Cohort were anti-HCV positive. Inmates ≥ 30 years of age had higher rates of seropositivity in both groups. Since only 5.3 % of the prison population was included in the Risk-Based Screening Group, an additional 4,877 HCV-positive inmates are projected to have not been identified in 2011–2012. Gaps in case identification exist when risk-based testing is utilized by PPS. A more comprehensive screening model such as opt-out universal testing should be considered to identify HCV-positive inmates. Identification of these individuals is an important opportunity to aid underserved high-risk populations and to provide medical care and secondary prevention.*

KEYWORDS *Hepatitis C virus, Correctional health, Testing strategies*

INTRODUCTION

An estimated 1.6 % of the US population is seropositive for hepatitis C virus (HCV), making it the most common chronic blood-borne infection in the country.¹ Among at-risk populations, including prison inmates, however, the seroprevalence can be much higher.^{2–6} HCV antibody positivity rates among incarcerated individuals from several correctional facility networks range from 12–34 %, over 20 times the national level.^{2–4,7,8} This has been attributed to the high prevalence of risk behaviors for HCV within this population, such as unsafe injection drug use (IDU) practices, noncommercial tattooing, and high-risk sexual practices.^{3,5,9,10} Continued engagement in risk behaviors after incarceration also facilitates the spread of HCV between formerly detained and community populations.⁹

Kuncio, Newbern, Fernandez-Viña, Johnson, and Viner are with the Philadelphia Department of Public Health, Division of Disease Control, 500 S. Broad St., Philadelphia, PA 19146, USA; Herdman is with the Philadelphia Prison System, Philadelphia, PA, USA.

Correspondence: Danica E. Kuncio, Philadelphia Department of Public Health, Division of Disease Control, 500 S. Broad St., Philadelphia, PA 19146, USA. (E-mail: Danica.kuncio@phila.gov)

The high prevalence of HCV in correctional facilities warrants special attention to ensure that this hard-to-reach population is tested for HCV, provided medical care while incarcerated, and linked to additional services upon release. According to population estimates, more than 40 % of chronically infected individuals do not know they are HCV-positive; thus, correctional facilities provide an opportunity for case finding and secondary prevention.^{8,11} Further, former inmates are a marginalized population once they are released, often unable to receive high standards of medical care.^{9,12} Therefore, appropriate measures need to be taken within the correctional system to ensure adequate care, including HCV RNA confirmatory testing, education, the consideration of treatment, and linkage-to-care for post-release.^{13,14}

While the Federal Bureau of Prisons recommends HCV testing for all high-risk inmates (i.e., anyone with evidence of a self-reported HCV risk factor, including a history of IDU or a blood transfusion before 1992),¹⁵ screening practices for HCV vary between correctional facilities. Screening strategies in institutions range from opt-out universal screening, opt-in testing, to risk-based testing.^{2,4,16} Choice of a testing strategy is likely influenced by the perception of disease prevalence, budget limitations, and the expected length of stay for each inmate. In facilities that utilize risk-based testing, reliance on self-reported risk factors is shown to limit case finding.¹⁷ This study further compares the level of disease found using current screening practices to the true seroprevalence of HCV in an urban correctional institution system. Findings can be used to guide future screening protocols and HCV-related programs at this and other facilities.

METHODS

Setting

The Philadelphia Prison System (PPS) is comprised of six jails and special detention sites that house greater than 8,800 inmates at any given time who are awaiting trial or serving sentences that are an average length of 2 weeks and no more than 2 years in duration.¹⁸ Upon arrival at PPS, all inmates receive a medical examination at one of three clinic locations and are compulsorily screened for syphilis and tuberculosis. Since 2003, PPS has conducted targeted HCV screening among those inmates who test HIV-positive (1–2 % of the prison population) or are self-reported IDU.

Protocol

In September 2012, the Philadelphia Department of Public Health (PDPH) collaborated with PPS to measure HCV seroprevalence among 1,289 inmates (PDPH Study Cohort). This cohort was composed of all detainees entering the prison system during an 8-day period. The PDPH Public Health Laboratory tested the remaining blood from compulsory syphilis testing for anti-HCV antibody (Ab; Siemens AdviaTM assay). HCV tests were blinded for all identifiers except gender and age group (<30 or ≥30 years).

Statistical Analysis

The seroprevalence in the PDPH Study Cohort was compared, in 2013, to that of the “high-risk” HCV population typically screened by PPS (Risk-Based Screening

Group). The relative risk and 95 % confidence interval for HCV positivity was calculated for each group. Chi-square analysis was used to compare gender and age group of individuals in both populations. Analysis was conducted using SAS 9.3 (SAS Institute, Inc., Cary, NC).

The PDPH Institutional Review Board reviewed and approved this study.

RESULTS

During 2011–2012, 51,562 unduplicated detainees were processed into PPS and 2,727 (5.3 %) were screened for HCV as “high-risk” individuals (Risk-Based Screening Group). During September 2012, all 1,289 newly incoming detainees were screened for HCV (PDPH Study Cohort). While gender distribution was similar across groups, a greater proportion of inmates in the Risk-Based Screening Group were ≥30 years of age than in the PPS population or the PDPH Study Cohort (76 % versus 49 % and 54 %, respectively) (Table 1).

Of inmates tested using risk-based screening, 57 % were HCV Ab positive (data not shown). Using this testing method, the anti-HCV positivity rate for the entire PPS population was 3 % (2,727/51,562) during 2011–2012 (Table 2). In contrast, the HCV Ab positivity rate within the PDPH study cohort was 11.9 % (154/1,289) (Table 2). For both groups, ≥30 years olds were more likely to be HCV Ab positive than inmates <30 years of age, regardless of gender (Table 2).

When the 2011–2012 gender- and age-stratified PDPH Study Cohort estimates were applied to the entire PPS population, the prison-wide seropositivity was 12.5 %, or 6,443 detainees over the 2-year study period (Fig. 1). While the predicted HCV seroprevalence was greater than the Risk-Based Screening Group estimates for

TABLE 1 Demographic profile of hepatitis C testing in the PDPH Study Cohort and the Risk-Based Screening Group (2011–2012) within the Philadelphia Prison System (PPS)

	HCV tested		Total PPS population (2011–2012)
	Risk-Based Screening Group (N=2,727)	PDPH Study Cohort (N=1,289)	
Gender, N (%)			
Female	388 (14)	222 (17)	8,358 (16)
Male	2,339 (86)	1,067 (83)	43,204 (84)
Age group, N (%)			
<30 years	668 (24)	646 (50)	23,873 (46)
≥30 years	2,059 (76)	635 (49)	27,689 (54)
Subgroups, N (%)			
Female <30 years	78 (3)	116 (9)	3,583 (7)
Male <30 years	590 (22)	521 (40)	20,290 (40)
Female ≥30 years	310 (11)	103 (8)	4,775 (9)
Male ≥30 years	1,749 (64)	532 (41)	22,914 (44)

TABLE 2 Hepatitis C virus antibody seroprevalance rates within the PDPH Study Cohort and Risk-Based Screening Group (2011–2012) in the Philadelphia Prison System

Demographics	Risk-Based Screening at PPS			PDPH Study Cohort		
	Total PPS (N)	% Anti-HCV(+)	Relative risk	Total study (N)	% Anti-HCV(+)	Relative risk
Total	51,562	3.0	–	1,289	11.9	–
Gender						
Female	8,358	2.7	–	222	12.6	–
Male	43,204	3.1	1.1 (1.0, 1.3)	1,067	11.8	0.9 (0.6, 1.4)
Age group						
<30 years	23,873	1.1	–	646	6.8	–
≥30 years	27,689	4.7	4.1 (3.6, 4.6)	635	17.3	2.5 (1.8, 3.5)
Subgroups						
Female <30 years	3,583	1.1	–	116	7.8	–
Male <30 years	20,290	1.2	1.1 (0.8, 1.5)	521	6.7	0.9 (0.4, 1.7)
Female ≥30 years	4,775	4.0	3.8 (2.6, 5.3)	103	18.4	2.4 (1.1, 5.0)
Male ≥30 years	22,914	4.8	4.5 (3.3, 6.3)	532	17.1	2.2 (1.1, 4.2)

all gender and age groups, inmates ≥30 years had the highest rate estimate of 17.3 % (Fig. 1). This suggests that the current risk-based screening protocol failed to capture an additional 4,877, or 76 % of the predicted HCV-positive inmates who were incarcerated in 2011–2012 (Fig. 1). Males ≥30 years of age represent approximately 61 % of these additional cases that are not captured though standard risk-based screening at PPS.

DISCUSSION

This study demonstrates that Philadelphia’s inmate population has an elevated HCV seroprevalence, six times the national estimate for the general population and four times the 2.6 % estimate for the non-institutionalized city population (PDPH

FIG. 1 Positive HCV cases identified by the Risk-Based Screening Group and additional unidentified cases projected from PDPH Study Cohort estimates.

Hepatitis Program estimate for Philadelphia).¹ This rate is consistent with other studies of incarcerated individuals nationwide, demonstrating that HCV is an extensive problem in jails and prisons. Most notably, these data highlight the failure of a risk-based screening protocol for HCV in a correctional facility. Correctional systems provide a unique opportunity to test for HCV infection among high-risk groups. Incarcerated populations are generally comprised of low income, minority, and poorly educated individuals who frequently participate in risk behaviors for HCV while also lacking access to adequate health care.^{3,9,19,20} Therefore, HCV screening methods within correctional facilities must attempt to identify and provide care to all inmates who are HCV-positive and unaware of their infection.

Currently, only 5 % of the PPS population is screened for HCV via the risk-based protocol that uses a HIV-positive status or a self-reporting a history of IDU. This small proportion of detainees identified as high-risk is inconsistent with studies indicating that rates of HCV risk behavior in correctional facilities are elevated and can exceed 50 %, ^{5,7,9,10,17,20} highlighting a gap in risk behavior detection. The inefficiency in relying on self-reported history of IDU has been shown elsewhere.¹⁷ This discrepancy may in part be the result of inmate reluctance to disclose risk factors and face potential punishment or legal action and highlights the inadequacy of using self-reported risk as a proxy for true prevalence. While testing within the Risk-Based Screening Group found the majority of tested detainees to be seropositive, this translated to capturing only 3 % of all inmates are HCV seropositive. The PDPH Study Cohort estimates demonstrated that an additional 9 % of the prison population, or more than 2,000 people annually, are HCVAb positive but remain undetected. Opt-out universal HCV screening of all prison entrants would adequately identify these individuals, the first step in meeting a facility's legal obligation to provide quality and equal medical care to institutionalized individuals.^{15,21} Identification of HCV infection before the onset of long-term complications is shown to be cost effective,²² and prison time may be the only opportunity when inmates have healthcare available.

Testing approaches within institutional settings may need to consider restricted budgets and short average lengths of detention (e.g., jails),^{2,13} but strategies must be comprehensive in light of these limitations. Individuals born between 1945 and 1965 ("baby boomers"), for example, are considered an at-risk group both in the general population and within correctional facilities.^{20,23} Due to the increased HCV prevalence in this population, the US Preventive Services Task Force recommends that baby boomers be targeted for one-time HCV screening.²⁴ A recent study of inmates at the Pennsylvania state prison system, however, indicates that baby boomer screening alone would identify a small fraction of the total cases in prison.² Indeed, the <30-year-old inmates in the PDPH Study Cohort also had an elevated incidence of HCV compared to the national estimate and would not have been identified by this strategy. This elevated HCV seroprevalence in youth populations correlates with nationwide increases in HCV infection among young IDU.^{16,25} Given these considerations, alternative risk-based HCV screening strategies may be insufficient for case identification. However, additional programmatic strategies may be paired with universal screening to address such individual institutional limitations as a restricted budget and recidivism and should be measured. Limiting unnecessary repeat testing by improving the tracking of recidivists, for example, may prevent unnecessary costs.

Having a substantial proportion of HCV-infected patients remain untested while housed in a correctional institution presents a critical missed opportunity. Identifying HCV-infected patients while they are housed in a correctional institution provides an opportunity to provide confirmatory testing and disease follow-up in a controlled setting. Shorter and less

complex drug regimens have even made treatment a possibility for inmates with short-term sentences, though high drug costs remain a barrier for many facilities.^{13,14} HCV-positive individuals who are not appropriately identified, educated, and cared for in prison will reenter the community without medical guidance, putting themselves at risk for complications from untreated hepatitis and the community at risk from disease transmission. Of course, increased testing and care of HCV-positive inmates needs to be accompanied by strong prison programs that can successfully link these individuals to additional medical care and social services upon release.²⁶ Case finding within prisons serves a critical role in the larger community's care of HCV-positive individuals as well as their contacts.¹³

This study has a few limitations. While the protocol for the PDPH study cohort ensured that all inmates were screened for HCV regardless of accused crime, race, age, gender, or any other known indicator, it did not measure these factors. It is therefore unknown what proportion of the PDPH study cohort would have been targeted by the high-risk testing approach and if this proportion would have been different than for the population tested in 2011–2012. There is no reason to suspect, however, that the study cohort represented a different population than the general inmate population. In addition, recidivism is common in prison populations, and the 3-year rate of reentry into PPS is approximately 59 %. The measurement of disease prevalence in the PDPH study cohort may have been affected by double counting some cases who were released and reintroduced during the study time period, though this is unlikely to have affected results due to the brevity of the study period.

This study highlights the failure of risk-based testing to identify the majority of individuals who are HCV-positive and advocates for universal screening of all inmates followed by appropriate healthcare, prevention, and post-release services to individuals who require assistance. For facilities lacking the means to take this approach, universal screening protocols may be streamlined to adapt to differences in budgets, rates of recidivism, average length of detention, and system infrastructure should be assessed. A reconsideration of prison risk-based screening protocols will help to prevent and control HCV infection and sequelae among the prison population, and throughout the larger community.

ACKNOWLEDGMENTS

The authors would like to acknowledge the work of the PPS staff, specifically Reed Domer-Shank. In addition, the Philadelphia Public Health Laboratory staff made this project possible. Funding for this analysis was provided, in part, through the Centers for Disease Control and Prevention Cooperative Agreement for Addressing Syndemics Through Program Collaboration and Service Integration (5U38PS003152).

REFERENCES

1. Armstrong GL, Wasley A, Simard EP, McQuillan GM, Kuhnert WL, Alter MJ. The prevalence of hepatitis C virus infection in the United States, 1999 through 2002. *Ann Intern Med.* 2006; 144(10): 705–714.
2. Larney S, Mahowald MK, Scharff N, Flanigan TP, Beckwith CG, Zaller ND. Epidemiology of hepatitis C virus in Pennsylvania state prisons, 2004–2012: limitations of 1945–1965 birth cohort screening in correctional settings. *Am J Public Health.* 2014; 104(6): e69–74.

3. Fox RK, Currie SL, Evans J, et al. Hepatitis C virus infection among prisoners in the California state correctional system. *Clin Infect Dis*. 2005; 41(2): 177–186.
4. Macalino GE, Vlahov D, Sanford-Colby S, et al. Prevalence and incidence of HIV, hepatitis B virus, and hepatitis C virus infections among males in Rhode Island prisons. *Am J Public Health*. 2004; 94(7): 1218–1223.
5. Gough E, Kempf MC, Graham L, et al. HIV and hepatitis B and C incidence rates in US correctional populations and high risk groups: a systematic review and meta-analysis. *BMC Public Health*. 2010; 10: 777.
6. Chak E, Talal AH, Sherman KE, Schiff ER, Saab S. Hepatitis C virus infection in USA: an estimate of true prevalence. *Liver Int*. 2011; 31(8): 1090–1101.
7. Solomon L, Flynn C, Muck K, Vertefeuille J. Prevalence of HIV, syphilis, hepatitis B, and hepatitis C among entrants to Maryland correctional facilities. *J Urban Health*. 2004; 81(1): 25–37.
8. Spradling PR, Rupp L, Moorman AC, et al. Hepatitis B and C virus infection among 1.2 million persons with access to care: factors associated with testing and infection prevalence. *Clin Infect Dis*. 2012; 55(8): 1047–1055.
9. Fazel S, Baillargeon J. The health of prisoners. *Lancet*. 2011; 377(9769): 956–965.
10. Tsang TH, Horowitz E, Vugia DJ. Transmission of hepatitis C through tattooing in a United States prison. *Am J Gastroenterol*. 2001; 96(4): 1304–1305.
11. Denniston MM, Kleven RM, McQuillan GM, Jiles RB. Awareness of infection, knowledge of hepatitis C, and medical follow-up among individuals testing positive for hepatitis C: National Health and Nutrition Examination Survey 2001–2008. *Hepatology*. 2012; 55(6): 1652–1661.
12. Wilper AP, Woolhandler S, Boyd JW, et al. The health and health care of US prisoners: results of a nationwide survey. *Am J Public Health*. 2009; 99(4): 666–672.
13. Spaulding AS, Kim AY, Harzke AJ, et al. Impact of new therapeutics for hepatitis C virus infection in incarcerated populations. *Top Antivir Med*. 2013; 21(1): 27–35.
14. Ghany MG, Strader DB, Thomas DL, Seeff LB. Diagnosis, management, and treatment of hepatitis C: an update. *Hepatology*. 2009; 49(4): 1335–1374.
15. Prisons FBo. *Clinical Practice Guidelines: Preventive Health Care*. Washington, D.C. : Federal Bureau of Prisons April 2013.
16. Kim AY, Nagami EH, Birch CE, Bowen MJ, Lauer GM, McGovern BH. A simple strategy to identify acute hepatitis C virus infection among newly incarcerated injection drug users. *Hepatology*. 2013; 57(3): 944–952.
17. Macalino GE, Dhawan D, Rich JD. A missed opportunity: hepatitis C screening of prisoners. *Am J Public Health*. 2005; 95(10): 1739–1740.
18. Philadelphia Prison System Performance Report. In: System PP, ed. Philadelphia, PA; July 8, 2014.
19. Tohme RA, Xing J, Liao Y, Holmberg SD. Hepatitis C testing, infection, and linkage to care among racial and ethnic minorities in the United States, 2009–2010. *Am J Public Health*. 2013; 103(1): 112–119.
20. Hennessey KA, Kim AA, Griffin V, Collins NT, Weinbaum CM, Sabin K. Prevalence of infection with hepatitis B and C viruses and co-infection with HIV in three jails: a case for viral hepatitis prevention in jails in the United States. *J Urban Health*. 2009; 86(1): 93–105.
21. ABA. *ABA Criminal justice standards on treatment of prisoners*: American Bar Association; February 2010 2009.
22. Shah BB, Wong JB. The economics of hepatitis C virus. *Clin Liver Dis*. 2006; 10(4): 717–734.
23. Nave RL. Baby boomers and the hepatitis C boom. *Ann Emerg Med*. 2013; 62(6): 19A–21A.
24. USPSTF. Screening for hepatitis C virus infection in adults: final recommendation statement. 2013; <http://www.uspreventiveservicestaskforce.org/uspstf12/hepc/hepcfinalrs.htm>. Accessed March 18, 2014.

25. McNamara BC, Losikoff PT, Huguenin L, Macalino GE, Rich JD, Gregory SH. *Increasing hepatitis C prevalence and associated risk behaviors among incarcerated young adults*. J Urban Health. May 31 2013.
26. Klein SJ, Wright LN, Birkhead GS, et al. Promoting HCV treatment completion for prison inmates: New York State's hepatitis C continuity program. *Public Health Rep*. 2007; 122(Suppl 2): 83–88.