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Cost-effectiveness of hepatitis C screening and treatment linkage intervention in US methadone maintenance treatment programs

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ABSTRACT

Background: We evaluated the cost-effectiveness of a hepatitis C (HCV) screening and active linkage to care intervention in US methadone maintenance treatment (MMT) patients using data from a randomized trial conducted in New York City and San Francisco.

Methods: We used a decision analytic model to compare 1) no intervention; 2) HCV screening and education (control); and 3) HCV screening, education, and care coordination (active linkage intervention). We also explored an alternative strategy wherein HCV/HIV co-infected participants linked elsewhere. Trial data include population characteristics (67% male, mean age 48, 58% HCV infected) and linkage rates. Data from published sources include treatment efficacy and HCV re-infection risk. We projected quality-adjusted life years (QALYs) and lifetime medical costs using an established model of HCV (HEP-CE). Incremental cost-effectiveness ratios (ICERs) are in 2015 US$/QALY discounted 3% annually.

Results: The control strategy resulted in a projected 35% linking to care within 6 months and 31% achieving sustained virologic response (SVR). The intervention resulted in 60% linking and 54% achieving SVR with an ICER of $24,600/QALY compared to no intervention from the healthcare sector perspective and was a more efficient use of resources than the control strategy. The intervention had an ICER of $76,500/QALY compared to the alternative strategy. From a societal perspective, the intervention had a net monetary benefit of $511,000–$975,600.

Conclusions: HCV care coordination interventions that include screening, education and active linkage to care in MMT settings are likely cost-effective at a conventional $100,000/QALY threshold for both HCV mono-infected and HIV co-infected patients.

1. Introduction

Hepatitis C virus (HCV) is now the leading cause of infectious disease deaths in the United States, exceeding HIV-related deaths and the top 60 infectious diseases combined (Ly et al., 2016). HCV is often transmitted through injection drug use and is highly prevalent among methadone maintenance treatment (MMT) program patients (Hagan et al., 2011). The National Viral Hepatitis Strategy has identified people who inject drugs as a priority population for HCV treatment to reduce HCV prevalence and prevent re-infection (Wolitski and Dan, 2016). The strategy calls for developing programs that test and educate people who use drugs and are at risk for viral hepatitis, and link those who are positive for HCV to viral hepatitis care and treatment. The strategy also identifies people living with HIV as a priority population for HCV testing and diagnosis due to higher liver-related mortality rate among HCV/HIV co-infected populations. Onsite screening for HCV in substance use disorder treatment programs can be cost-effective (Schackman et al., 2015), but onsite testing is rare (Frimpong, 2013) and many programs that test onsite rely on passive referrals to HCV treatment and evaluation; few evidence-based models exist for active linkage to care after receiving a positive test result in this setting. A hepatitis care coordination program, evaluated in a randomized trial conducted in MMT programs in San Francisco, CA and New York City, NY, was found to show efficacy for linkage to HCV care (Masson et al.,

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2013). Among HCV-antibody positive participants, those receiving the screening, education, and care coordination intervention were significantly more likely to receive an HCV evaluation within 6 months than those receiving screening and education alone (Masson et al., 2013).

We evaluated the cost-effectiveness of this screening, education, and care coordination intervention using data from this trial, including intervention efficacy and resources used to deliver the intervention, and established computer simulation model of HCV disease to project lifetime quality-adjusted life year (QALY) and cost outcomes. We report cost-effectiveness results from the healthcare sector perspective and the societal perspective, following recent cost-effectiveness guidelines (Neumann et al., 2017).

2. Methods

2.1. Analytic overview

We compared the cost-effectiveness of HCV screening and care linkage strategies in an MMT setting for individuals meeting the HCV-related trial entry criteria. We initially evaluated three strategies: (i) no intervention; (ii) HCV screening and education (control); and (iii) HCV screening and education for all plus care coordination (i.e., active linkage to care) for all HCV-infected patients (intervention). In a secondary analysis, we added a fourth strategy, HCV screening and education for all and care coordination only for HCV mono-infected patients (HCV only strategy). The fourth strategy was evaluated to explore trial results, indicating that many HCV/HIV co-infected participants in the control arm were successfully linked to HCV care, presumably through other systems of care available to HIV-infected individuals. For each strategy, a decision tree decision analytic model (Petrou and Gray, 2011) describes test acceptance, receipt of results, and linkage to care (Fig. 1). HCV antibody test and RNA test sensitivity and specificity are included in the model (Table 1). The decision analytic model was programmed in TreeAge Pro version 2016 (Williamstown, MA, USA).

Subsequent outcomes including sustained virologic response (SVR), the possibility of HCV re-infection (Fig. 1), and lifetime outcomes were projected using an established computer simulation model of HCV disease and treatment (Hepatitis C Cost-Effectiveness model: HEP-CE) (Linas et al., 2017). The HEP-CE model simulates chronic HCV disease progression through three stages of liver disease: mild to moderate fibrosis, cirrhosis, and decompensated cirrhosis. Each disease stage is associated with a decrease in quality of life and an increase in healthcare costs (Table 1). If simulated individuals with chronic HCV become cirrhotic, they have an increased risk of mortality attributable to their liver disease. Simulated individuals without chronic HCV infection at baseline have a probability of HCV infection; simulated individuals who achieve SVR after treatment have a probability of re-infection if they engage in injection drug use risk behavior. Simulated individuals who are HIV-infected or HCV/HIV co-infected are assigned HIV-attributable mortality, HIV-related health-care costs and quality of life weights (Table 1). All simulated individuals in the model have an elevated mortality risk (standardized mortality rate) compared to the general population (Evans et al., 2015). The model has been validated by comparing HCV natural history all-cause mortality from a simulated cohort of patients to data from long-term observational studies (Linas et al., 2016). To ensure stability of results, the HEP-CE model was simulated with cohorts of 1 million individuals.

Outcomes include lifetime costs (2015 US$) and quality-adjusted life years (QALYs), both discounted at 3% annually. Costs estimated from the health sector perspective include costs to MMT programs (which may or may not be reimbursed), downstream costs for HCV and HIV healthcare, and unrelated healthcare costs (Supplemental Tables 1–4). Incremental cost-effectiveness ratios (ICERs) are calculated from the healthcare sector perspective as the additional cost per QALY gained compared to the next least expensive strategy after eliminating strategies due to dominance (when one strategy is more effective and costs less) or extended dominance (when a combination of alternative strategies is a more efficient use of resources than the dominated strategy) (Neumann et al., 2017).

As recommended by recent cost-effectiveness guidelines (Neumann et al., 2017), we used an impact inventory to consider potential impacts of the intervention outside of the healthcare sector (Supplemental Table 5). We assigned a societal willingness-to-pay of $100,000/QALY, a commonly used threshold in the United States that more appropriately reflects contemporary medical costs than the $50,000/QALY threshold used in earlier studies (Braithwaite et al., 2008; Neumann et al., 2014). We calculated net monetary benefit for each strategy from the societal perspective. Net monetary benefit uses the willingness-to-pay threshold to convert QALY benefits to monetary units, then subtracts the cost of the intervention to determine the net monetary benefit (Neumann et al., 2017). For the societal perspective analysis, we also assigned costs to the participants for their time spent during the intervention (education, testing, and care coordination) (Table 1), and included future productivity and consumption effects. Results are reported calculating productivity effects, both assuming national labor force participation rates (U.S. Bureau of Labor Statistics, 2015a) for all individuals and assuming the average labor force participation rate reported by trial participants (16.3%) for individuals under age 65. The Weill Cornell Medical College institutional review board (IRB) approved the cost-effectiveness analysis; sites obtained approval from their IRBs to conduct the randomized controlled trial and to share data.

2.2. Trial data

Eligible participants were at least 18 years old, reported being either HCV antibody negative, of unknown HCV status or, if HCV positive, with no prior medical care or diagnostic evaluation for HCV (liver biopsy, viral load test, genotype test, liver imaging) and willing to participate in all study-related activities (Masson et al., 2013). The trial was conducted in February 2008–June 2011. A total of 489 participants were randomized across both sites; 244 were assigned to the intervention group and 245 were assigned to the control group. Only results from individuals with complete HIV and HCV status information were included in this analysis resulting in a total sample of 480 (232 from the intervention group; 226 from the control group).

Consenting participants were tested for Hepatitis A, B, and C, and for HIV. If the participant tested positive for HCV antibodies, HCV linkage referrals were made to an affiliated clinical setting where an HCV RNA test and liver staging would be conducted (Masson et al., 2013). Participants who, on the basis of serological tests results, were susceptible to Hepatitis A or Hepatitis B or both were offered combination vaccine onsite at the MMT program (Masson et al., 2013). Both the intervention and control group received individual 2-session manual guided HIV and viral hepatitis counseling and education administered by research staff (Masson et al., 2013). The intervention group received education sessions delivered with motivational interviewing and motivational interviewing-enhanced case management assistance with off-site HCV evaluation for 6 months (Masson et al., 2013). Case management sessions were held weekly.

2.3. Model inputs

Cohort characteristics including age, proportion male, proportion HIV-infected, proportion with HCV and proportion currently injecting drugs were from trial participants (Table 1). Individuals in a hypothetical no intervention strategy were assigned a probability of being tested for HCV outside of the intervention (background testing) based on the median time reported since the most recent HCV test by HCV-uninfected trial participants. Individuals in the no intervention strategy who were tested outside of the intervention and tested positive were then assigned the same probabilities of linking to care and successful