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The Impacts of Increasing Treatment Uptake Rate of Hepatitis C Virus Infection in Indian Punjab on Some Important Societal Parameters

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Abstract

Health economic studies for making decisions on disease management interventions usually focus on evaluating cost-effectiveness or net monetary benefits of the interventions. But there can be other societal benefits of these interventions which can motivate policymakers to adopt them. Our disease of interest is Hepatitis C virus (HCV) infection, which causes more deaths than HIV infection in India. In advanced stages, the only cure is liver transplantation whose costs are more than ten times of India's annual per-capita income. Indian Punjab has a high HCV prevalence of 3.6% and is also struggling with the menace of injecting drug use which is a major contributor to HCV spread. In early stages of HCV infection, injecting drug users (IDUs) might not know of their infection status; thus, increasing screening and treatment uptake can lead to more IDUs leaving the practice. Nearly 75% of the injecting drug users in Punjab are below 30 years of age, and as most people in the state are also below this age, the risk of infection in young people becomes a concern for economic productivity and life expectancy- the latter becomes enhanced for young individuals as HCV is a slowly progressing disease and while the lifespans of older people are not expected to be affected significantly, reduction in the lifespans of younger people can be significant if not treated. The most effective standard-of-treatment is directly-acting antivirals (DAAs). Models assessing impacts of DAAs in the Indian context have neither incorporated HCV transmission nor evaluated impacts on important societal parameters like age structure of infected patients, IDU prevalence, contribution of HCV to overall mortality and liver transplants needed. We developed an agent-based simulation for modelling HCV transmission in an open cohort. We modelled disease progression using a widely used discrete-time Markov chain. The model was calibrated and validated after execution over a fifty-year period; then we added a treatment component where infected individuals were treated at the end of every year for a ten-year period to achieve a targeted treatment uptake rate. The experiments were carried out for five uptake rates- 10%, 30%, 50%, 70% and 90% of all infected agents. By increasing the uptake rate from 10% to 90%, we observed the following trends in parameter estimates (reported as means of three replications, with respective standard deviations inside parentheses):

1. At the end of the treatment period, the percentage of infected agents below the age of 18 years monotonically decreased from 13% (0.4%) to 7.5% (0.5%), while that above the age of 30 years monotonically increased from 66.5% (0.7%) to 72.4% (0.3%). The IDU prevalence monotonically reduced from 0.081% (0.01%) to 0.044% (0.006%).
2. Over the sixty-year period, the contribution of HCV to overall mortality monotonically decreased from 6.7% (0.2%) to 1.4% (0.09%). The percentage of the general population undergoing liver transplants monotonically decreased from 0.21% (0.015%) to 0.05% (0.005%). A more noticeable reduction was when this percentage was calculated based on the number of infected agents- there was a monotonic decrease from 5.4% (0.27%) to 1.8% (0.16%).

Keywords
Hepatitis C Virus Infection, Indian Punjab, Agent-based Simulation, Directly-acting Antivirals and Treatment Uptake Rates.

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