Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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The use of mathematical modeling to inform drug policy making

In this special collection, we present a series of papers which highlight the varied ways mathematical and economic models are being applied to inform drug policymaking, with specific focus on prevention of hepatitis C virus (HCV), HIV, and overdose among people who use or inject drugs. The variety of modeling approaches discussed in this issue (deterministic compartmental modeling, individual-based network modeling, economic and cost-effectiveness modeling), as well as the breadth of applications (HIV, HCV, overdose) and settings (U.S., Canada, Mexico, Tanzania), highlights different examples of how modeling evidence is being used to improve the health of people who use drugs. From quantifying structural drivers of epidemics (such as criminalization and incarceration) to decisions about who pays for what, modeling continues to play an important role in informing and guiding evidence-based drug policy.

The emerging opioid overdose crisis in North America is addressed in two articles. Irvine and colleagues provide an important case study as to how modelers and policymakers collaborated to generate useful simulations of public health strategies to support the response to the opioid overdose crisis in British Columbia, Vancouver (Irvine et al., 2019). Colleagues from the Opioid Use Disorder Modeling writing group provide a commentary detailing the variety of uses for simulation models for considering the epidemic of opioid use disorder in the US, and interventions to tackle the epidemic (Group, 2020). Together, these pieces highlight the challenges this rapidly emerging situation poses to modeling, but the important role that modelers can play in informing public health strategies and policy. We hope that a coordinated effort amongst modeling teams occurs, each of whom can provide different methodological approaches and viewpoints on the problem, as well as facilitate data sharing. Indeed, these coordinated modeling and data sharing efforts have helped inform the public health understanding and response to HIV as well as, more recently, coronavirus (Eaton et al., 2014; Xu & Kraemer, 2020).

Along with overdose, hepatitis C virus (HCV) infection remains an important cause of morbidity and mortality among people who inject drugs. The World Health Organization (WHO) elimination goal of 80% reduction in HCV incidence by 2030 underscores the urgent need to scale-up treatment and prevention interventions for PWID to prevent transmission and mortality (World Health Organization, 2016). Two studies in this issue examine the potential role of prison in the elimination response. Godin, Kronfli, Cox, Alary and Maheu-Giroux, (2020) find that prison-based testing and treatment could play an important role at reaching the WHO incidence target in Montreal, Canada (Godin et al., 2020). Indeed, due to frequent incarceration and short sentences, scaling up prison-based testing and treatment in Montreal could reduce HCV incidence among all PWID by roughly 40% by 2030, with further impact being achieved if this is done in combination with improved harm reduction interventions.

In another study from Perry County, Kentucky, a rural area at the center of the current opioid overdose crisis, Stone and colleagues find that the risks associated with incarceration may contribute up to 43% of new HCV infections over the next decade (Stone, Fraser, Young, Havens & Vickerman, 2020). To reduce this risk, their analyses show that OST and NSP need to be scaled up in the community, combined with prison-based OST and retention on release. Importantly, they also find that decriminalization plus diversion to OST could prevent over half of new HCV infections in the next ten years, underscoring the substantial benefit that drug policy reform could have in the U.S.

The majority of HCV burden lies in low-middle income countries (LMIC), and two studies in this issue examine what is required to achieve HCV elimination in LMIC settings. In 2019, Mexico became the first country in Latin America to commit to HCV elimination, with the study by Marquez and colleagues finding that even in a setting where 95% of PWID have a history of HCV infection (i.e., antibody positive) and harm reduction is minimal, HCV elimination is possible through an intensive combination prevention scale-up approach,(Marquez et al., 2020). Unfortunately, their modeling also shows that current government funding of compulsory abstinence programs could hamper these efforts, highlighting the need for scale-up of evidence based OST.

In a separate study in Dar es Salaam, Tanzania, Scott and colleagues quantify the substantial economic cost of HCV disease among PWID, estimated to be nearly USD$30 million over 2018–2030 (Scott et al., 2019). Their dynamic model indicates important benefits of existing harm reduction programs in preventing HCV. They additionally show that testing and treatment programs are likely to be cost-effective, with HCV core antigen (HCVcAg) testing potentially having greater impact compared to antibody and confirmatory PCR as a result of its simplified diagnostic process and resulting better retention in care.

We now know that HCV elimination can theoretically be achieved in many different settings, as shown by an array of models using different model structures and assumptions. Empirical studies are now needed to show it can become a reality, such as the Surveillance and Treatment of Prisoners with Hepatitis C (SToP-C) project, a study evaluating the scale-up of HCV treatment on HCV incidence within prisons in Australia. This will help validate these models and confirm that treatment of individuals can prevent transmission at a population level. In situations where HCV treatment and prevention programs are implemented, modeling is also still important for evaluating the impact achieved and to help direct those programs (Walker et al., 2020).

In an essay in this issue, Rhodes & Lancaster, 2020 critically evaluate the evidence that is produced by these and other HCV elimination modeling studies from a social science perspective (Rhodes & Lancaster, 2020). They use ideas from science and technology studies (STS) to trace how modeling projections act as 'performative actors' in evidence-making for HCV elimination. This helps to notice how modeled

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projections are having social and material impacts, including in policy, and through the numerical targets they generate. We agree with their call that closer collaboration between social scientists and modelers will allow for a deeper and more nuanced understanding of how modeling influences policymaking, and our role as modelers in this process.

The final two papers in this special issue address and compare different methodological modeling approaches. In contrast to the deterministic compartmental modeling studies featured in this special issue, Bellerose and colleagues review the literature on different individual-based network modeling approaches for HCV and HIV transmission among PWID (Bellerose et al., 2019). In particular, they discuss the importance of dynamic network approaches which allow for partnerships to evolve and disintegrate over time, but are hard to parameterize, as well as the importance of including both sexual and injecting networks to more accurately represent HIV transmission.

In the final paper, Stuart and Wilson discuss and compare three methodological approaches to determining cofinancing strategies for structural interventions which have multi-sectoral benefits (Stuart & Wilson, 2020). In these situations, how much should the HIV sector pay? Stuart and Wilson highlight the substantial difference in conclusions based on different cofinancing approaches using cost-benefit analysis, game theory, and allocative efficiency. In the era of dwindling HIV financing, the question of who should pay (and how much) for structural interventions which have multiple benefits is a critical question to inform efficient and fair resource allocation, and to ensure future sustainability.

This issue presents modeling analyses that predominantly focus on a single health outcome, such as HIV, HCV, or overdose. Yet, the syndemics of substance use, incarceration, infectious disease transmission, and overdose are highly complex and overlapping (Singer, 2009). We hope that future models will stop focusing on single health outcomes, and increasingly consider the many forms of harm that result from injecting drug use as well as the multiple health benefits from interventions. Indeed, interventions such as OST can prevent HIV and HCV transmission, overdose, as well as reduce reincarceration and improve HIV treatment uptake and retention (Degenhardt et al., 2019). Models are well poised to incorporate these complex, and possibly synergistic, interactions to fully quantify the benefits of public health interventions for people who use or inject drugs (Degenhardt et al., 2019). This broader view could also help challenge the siloed funding Stuart and Wilson discuss, because most interventions have multiple benefits for this group.

Among substance using populations, global access to treatment for HIV and HCV and harm reduction interventions such as OAT and NSP is woefully low (Larney et al., 2017). Inaction will result in substantial economic burden and preventable deaths. Policymakers urgently need information on how to quickly, efficiently, and affordably tackle these complex problems, and the benefits of doing so; modeling can help inform these critical discussions.

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