Preliminary Integrated Approach to Modeling the Prescription and Illicit Opioid Epidemic

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Opportunity
Use differential equations continuous modeling approach to conduct a preliminary exploration into the systems dynamics of the prescription and illicit opioid epidemic

BACKGROUND
- Nearly 0.5 million people have died from opioid related overdoses over the course of the last two decades [1]
- In 2014, 4.3 million people over the age of 12 were estimated to be currently misusing pain relief medication [2]
- Reports indicate that roughly 4% of individuals misusing prescription opioids will transition to heroin and 80% of heroin users initially began by abusing prescription opioids [2]
- Evidence for effective interventions remains weak [3]

Approach
1. DEVELOPED SYSTEM OF DIFFERENTIAL EQUATIONS TO CAPTURE DYNAMICS
- Identified fundamental states
- Characterized state transitions

2. IDENTIFIED SIGNIFICANT GAPS IN CURRENT PRESCRIPTION AND ILlicit OPIoid RESEARCH
- Applied computational search to parametrize equation system against historical opioid-related overdoses in Massachusetts in order to compensate for gaps

3. CONDUCTED SENSITIVITY ANALYSIS TO IDENTIFY HIGHEST IMPACT PARAMETERS

4. EXTENDED AGGREGATE FRAMEWORK TO NETWORK OF TOPOLOGICALLY COUPLED MASSACHUSETTS COUNTIES

5. EXTRAPOLATED MODEL TO 2030 AND SIMULATED INTERVENTIONS
- Projected to future time-steps
- Explored different interventions
- Reduction in acute and chronic prescription rates
- Reduction in social initiation
- Increase in overdose death (Naloxone administration)
- Increase in treatment (access to or effectiveness of rehabilitation)
- Increase in prescription opioid availability

Results

Impact
IDENTIFICATION OF CHRONIC PRESCRIBING AS THE HIGHEST IMPACT PARAMETER
- Increase in chronic prescribing leads to significant growth in prescription misuse and heroin use populations and consequently in death rates
- Decrease in chronic prescribing leads to reductions across prescription misuse, heroin use and overdoses

HIGHLIGHTING INCREASED HEROIN POTENCY IN HISTORICAL OVERDOSE DEATHS
- Supported by increased prevalence of fentanyl in toxicology tests in Massachusetts overdose deaths [4]

EMPHASIZING THE PRESCRIPTION MISUSE-TO-ILLICIT OPIOID PIPELINE AS A DRIVER IN INCREASING OVERDOSE DEATHS
- Significant implications for legislative approaches to epidemic relief
- Heroin potency leads to higher rates of addiction and death as opposed to prescription opioids
- Highlights need for further research into illicit opioid economic systems