FRED Simulator for Opioid Use Disorder and Overdose

Website End-User Guide

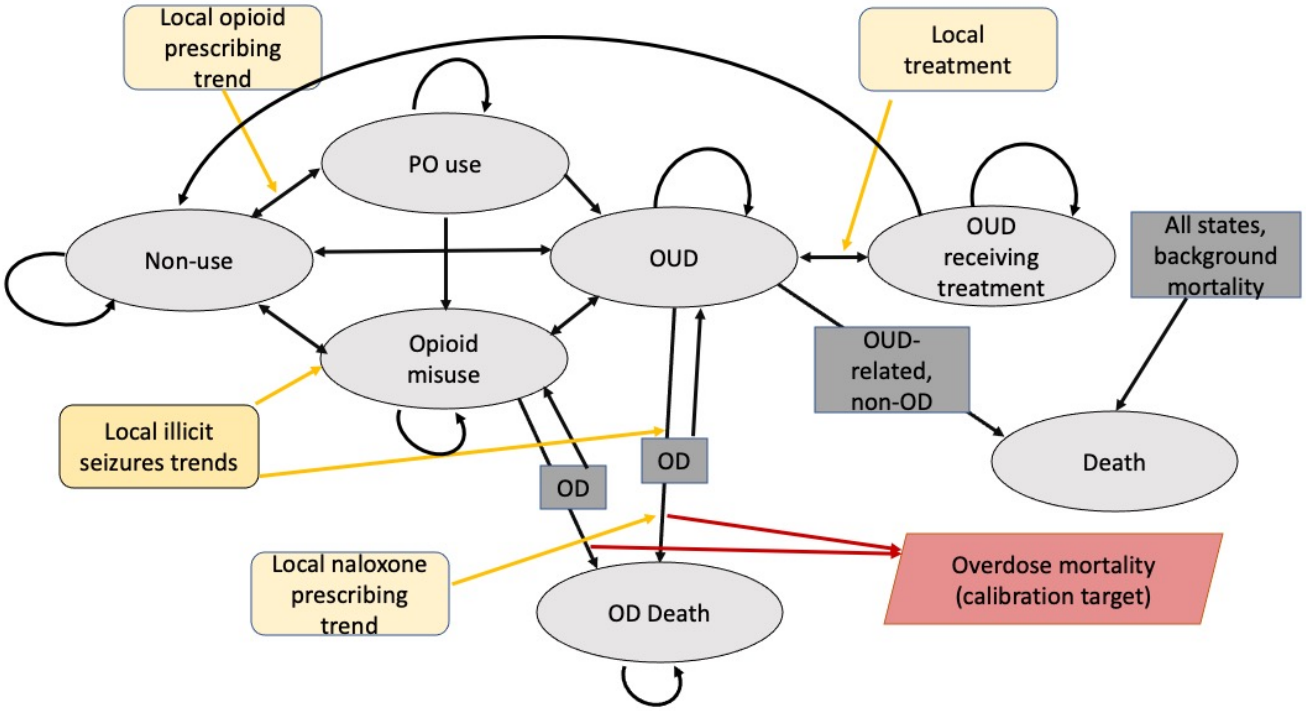
Instructions for Use of the FRED Simulator

for Opioid Use Disorder and Overdose

Overview

FRED (A Framework for Reconstructing Epidemiological Dynamics) is an agent-based simulation modeling platform for exploring and simulating the spatial and temporal patterns of epidemics. Agents represent people who are members of the modeled population, which is created from US census data. Like people, agents have personal characteristics, like gender and age, and are grouped in realistic households.

The FRED Simulator for Opioid Use Disorder (OUD) and Overdose uses an agent-based model to simulate opioid use, OUD and death due to both overdose and other opioid use related mortality factors. A model is a logical framework intended to represent a system by including the important characteristics of that system. Below is a simplified schematic of the FRED OUD model, with disease states and their transitions.



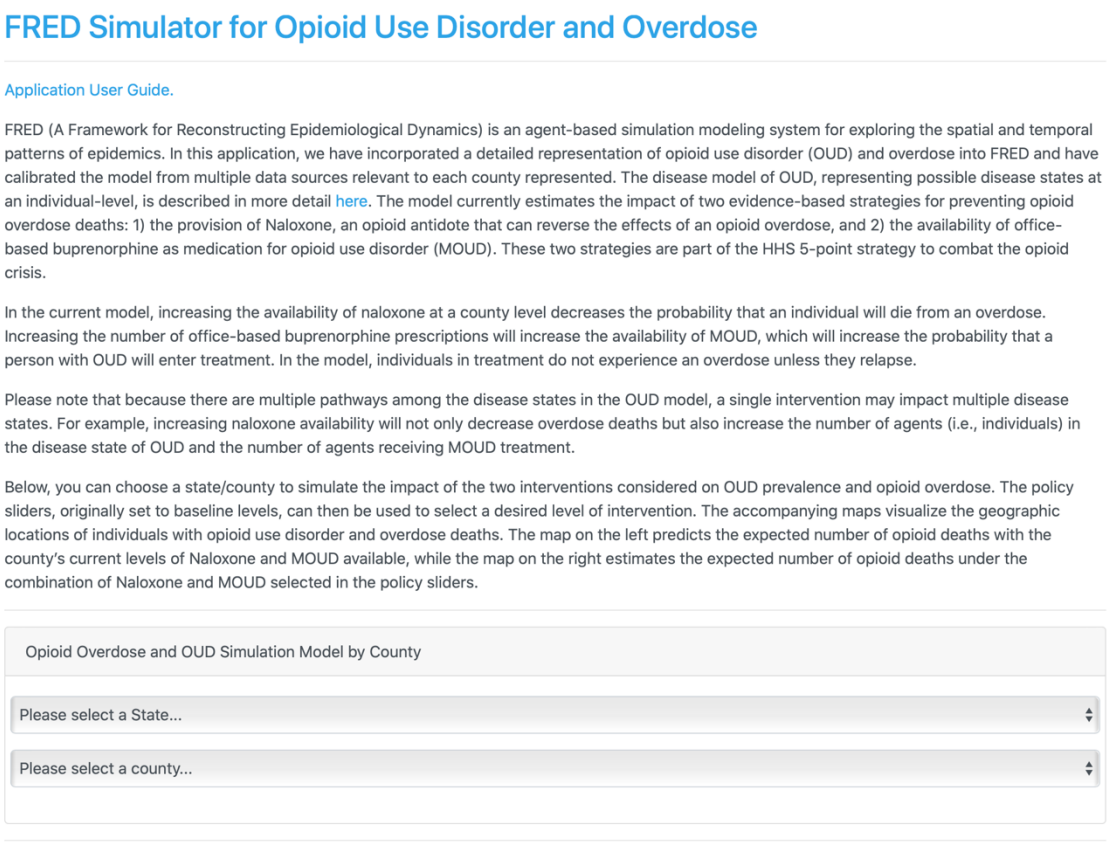
In this application, we have incorporated a detailed representation of opioid use disorder and overdose at the individual level into FRED and have calibrated the model from multiple data sources relevant to each county represented. Agents in the simulation population transition through the model states based on probabilities specific to the agent and the current state. Agents in the non-use state do not use opioids of any kind. Individuals in the PO use state are agents with legal prescriptions who do not misuse opioids. Agents in the opioid misuse state represent individuals who misuse prescription opioids and/or use illicit opioids such as heroin and illicitly manufactured fentanyl. Agents in the *OUD* state have the disease of OUD. *OUD receiving treatment* represents agents who had OUD and are receiving medication for opioid use disorder (MOUD). Agents may relapse from treatment to OUD or may enter a state of non-use. Agents who experience an overdose event may die or return to their state prior to the overdose. Agents in any of the disease states also may die from non-overdose related causes at rates dependent on their disease state in the model.
The disease model currently estimates the impact of two evidence-based strategies for preventing opioid overdose deaths: the provision of Naloxone and the availability of buprenorphine prescriptions as MOUD. These two strategies are part of the HHS 5-point strategy to combat the opioid crisis.

In the current model, increasing the availability of naloxone at a county level decreases the probability that an individual will die from an overdose. Increasing the number of office-based buprenorphine prescriptions will increase the availability of MOUD, which will increase the probability that a person with opioid use disorder will enter treatment. Individuals in treatment do not experience an overdose unless they relapse.

Initial View

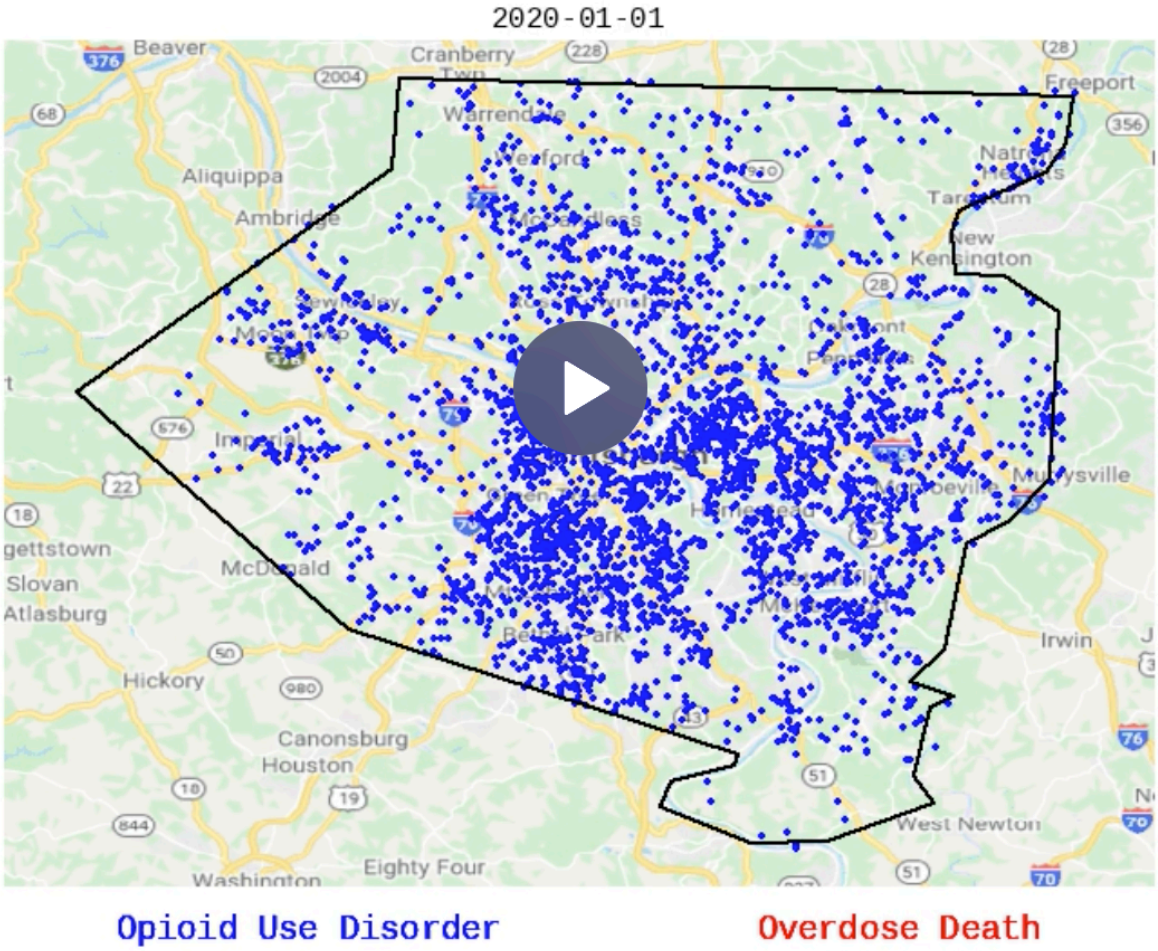
When first viewing the website, end-users will need to select a state and a county within that state to see simulation results.

Select a location by choosing first a state and then a county from the drop-down menu.



After a location is selected, the results of the baseline simulation with no interventions will be displayed in the lower left of the screen. The lower right side of the screen will only display a message at this point. Simulations time series results include a point for the home location of each agent with opioid use disorder and each overdose death. Initially day 0 of the simulation will be displayed. To view a time-series of results over the simulation period, click the "Play Simulation" button located over the results map.

Play Simulation



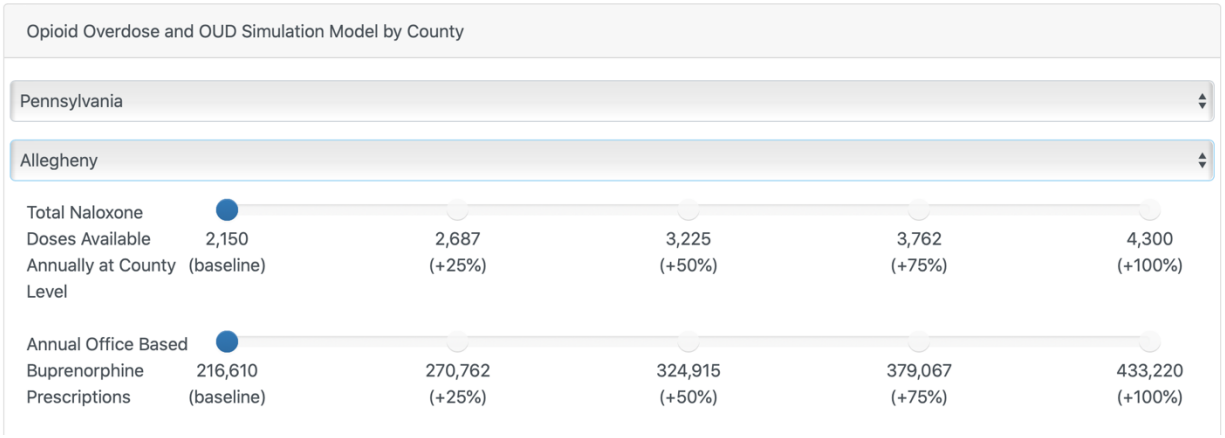
Over the baseline simulation period (2020 through 2024),

- 62,809 +/- 43 cases of opioid use disorder (mean +/- S.E.M.)
- 2,558 +/- 14 overdose deaths (mean +/- S.E.M)

A time-series of results, the location of the simulation, the simulation date of each frame of the video and the number of agents with opioid use disorder and number of deaths from overdose during the simulation period are shown in the movie. Results are visualized for the simulation with the median number of overdose deaths. Mean along with standard error of the mean for

overdose deaths and the number of agents with opioid use disorder for the set of simulations are listed under the movie.

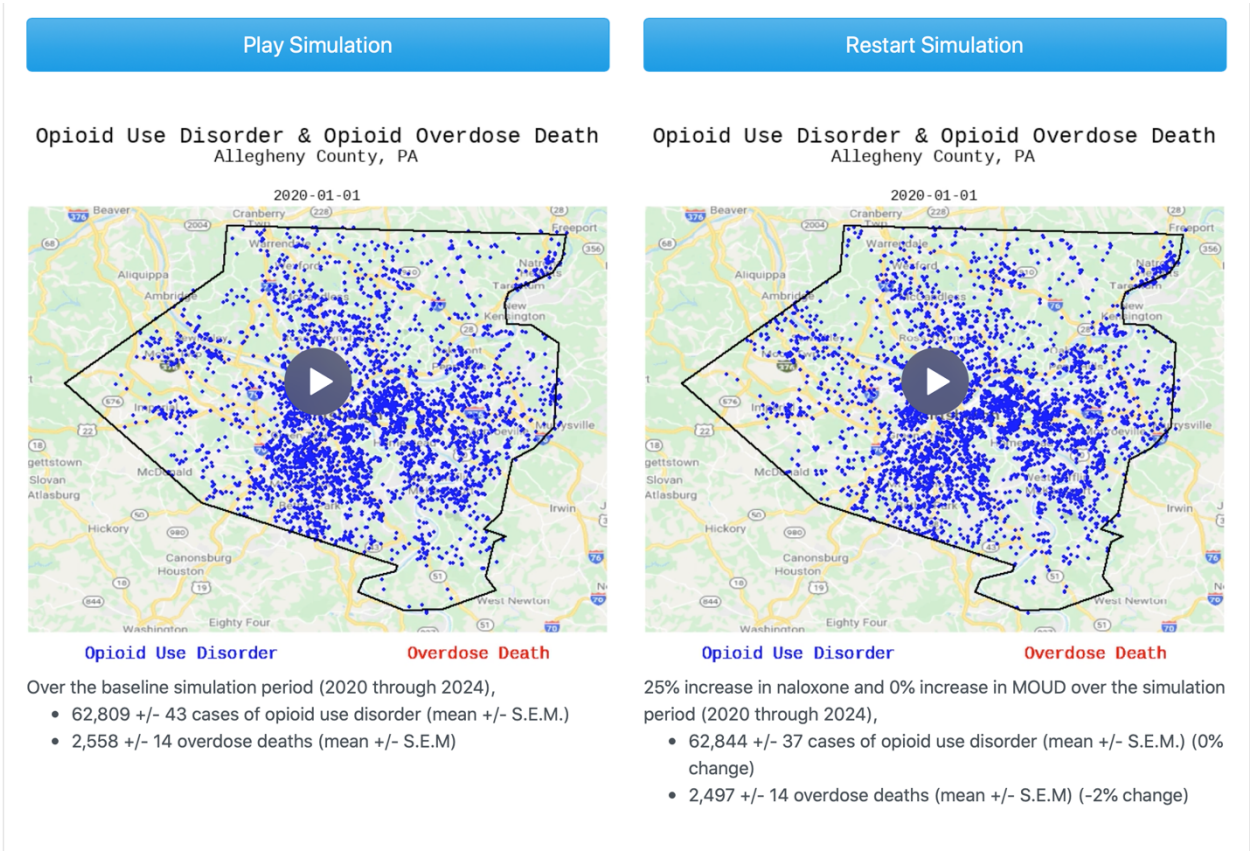
Sliders to choose levels of interventions are located below the drop-down menus for locations.



The sliders show the levels of the 2 interventions, increase in the total doses of naloxone per county and increase in the annual number of office-based buprenorphine prescriptions per county. Increasing the availability of naloxone at a county level decreases the probability that an individual will die from an overdose. Increasing the number of office-based buprenorphine prescriptions increases the probability that a person with opioid use disorder will enter treatment.

The baseline level for both variables is listed on the far left. Slider set positions at 25, 50, 75 and 100% increases are posted below the appropriate slider. End-users can select any combination of increases, for example an end-user can select to see the effect of only a 50% increase in naloxone supply or of a 50% increase in naloxone supply combined with a 25% increase in office-based buprenorphine prescriptions.

After choosing one or two interventions, an additional map will display on the right showing the results of the selected simulation.



Each red dot represents a single overdose death, but due to the higher prevalence of opioid use disorder (OUD) and the limitations of displaying large geographical areas on small visual displays, each blue dot represents 20 cases of OUD.

Clicking “Play Simulation” will play both videos from their current position. When videos are playing the “Play Simulation” button changes to “Pause Simulation”, so the simulation can be stopped at any point. The date under the title of the simulation lists the date of that frame in the overall time-series. When the simulation is paused, it can be restarted from the current position using “Play Simulation” or restarted from day 0 using the “Restart Simulation” button. Videos can be downloaded by right-clicking on the video, depending on the browser being used.

The size of the synthetic population for the selected area is displayed under the simulation videos.