Supplementary replication code to "Cost-effectiveness of expanding the capacity of opioid agonist treatment in Ukraine: Dynamic modeling analysis"

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In this document, we provide the code that allows replication of the modeling results presented in the paper and in the Supplement. The code presented below uses the sample from the joint distribution of model parameters and the functions that are supplied as separate files. The tables and figures included in the paper and in the Supplement are based on using these functions for a range of strategies and multiple draws from the joint distribution of model parameters.

Load the functions that implement the analysis (change the path if needed; packages 'dplyr' and 'deSolve' need to be installed).

```
source('oat_capacity_functions.R')
```

Set the value for the location variable: 1 = Kyiv, 2 = Mykolaiv, and 3 = Lviv.

```
city <- 3
```

Set the value for the scenario variable (rates):
1 = base case peer effects assumption
2 = scenario when some OAT patients contribute to opioid use initiation and relapse rates
0 = no peer effects assumed besides capacity-dependence of OAT drop-out rate

```
rates <- 1
```

Load and merge samples from the joint distribution of model parameters (change the path if needed).

```
load('smpl_joint_same50K.Rdata')
if (city==1){
   load('smpl_joint_kyiv50K.Rdata')
   joint <- smpl.joint.city(smpl.joint.same, smpl.joint.k)}
if (city==2){
   load('smpl_joint_mykolaiv50K.Rdata')
   joint <- smpl.joint.city(smpl.joint.same, smpl.joint.m)}
if (city==3){
   load('smpl_joint_lviv50K.Rdata')
   joint <- smpl.joint.city(smpl.joint.same, smpl.joint.l)}
```

Compute summary statistics (marginal means and 95% CI) for the model parameters.

```
par.sum.city <- param.sumry(joint, city, rates)
kable(par.sum.city)
```

var.name	mean	95%CI.low	95%CI.high
lam (t=0)	0.025	0.013	0.044
lam0	0.01	0.001	0.022
lam1	0.099	0.059	0.138
alpha.f (t=0)	0.202	0.161	0.261
alpha0.f	0.198	0.158	0.256
alpha1.f	0.062	0.025	0.129
irr.alpha	0.233	0.146	0.342
k.al	5.084	3.499	7.127

var.name	mean	95%CI.low	95%CI.high
delta	0.168	0.119	0.229
gamma	0.099	0.074	0.13
rho.n (t=0)	0.264	0.209	0.331
rho0.n	0.221	0.173	0.277
rho.f (t=0)	0.298	0.252	0.357
rho0.f	0.256	0.216	0.302
rho1	0.277	0.16	0.454
mu.s (t=0)	0.145	0.128	0.167
mu0.s	0.122	0.105	0.14
mu1.s	0.319	0.107	0.6
irr.mu	0.78	0.644	0.936
k.mu	5.076	3.486	7.12
u	0.32	0.27	0.372
p	0.535	0.499	0.571
m.DU	0.12	0.092	0.153
m.OAT	0.037	0.031	0.044
m.A	0.029	0.023	0.034
S0	38432.209	31756.307	42812.838
E0	31110.542	30661.54	31405.171
On0	5385.756	2884.126	9192.047
Of0	162.991	21.066	370.3
Q0	1893.095	963.313	3330.989
A0	2547.406	1279.912	4515.406
N0	79674	79674	79674
v0	0.952	0.911	0.993
w0	0.971	0.945	0.996
hrqol.S	0.833	0.83	0.835
hrqol.E	0.781	0.777	0.785
hrqol.A	0.735	0.702	0.767
hrqol.DU	0.636	0.627	0.645
dif.hrqol.OAT.DU	0.045	0.027	0.063
inj.On	525.434	461.412	602.119
inj.Of	375.609	303.954	459.716
inj.Q	530.229	469.418	602.836
inj.OAT	81.582	20.4	162.585
cost.busy.s	305.793	186.382	426.024
cost.busy.p	391.725	239.274	547.679
cost.idle.s	65.978	40.24	92.05
cost.idle.p	79.951	48.737	111.614
r	0.03	0.016	0.052

Specify the modeling horizon and the times at which explicit estimates of the system state values are desired.

```
ppy <- 365 # number of periods per year that determine the frequency of explicit system dynamics evaulation
# (set to 365 if daily values are desired, to 12 if monthly values are desired, etc.)
times <- seq(1, ppy*10, by=1) # set ppy*5 for 5-year and ppy*20 for 20-year horizon
```

Define the OAT capacity strategy: number of OAT slots at the specialty and primary care facilities.

```
Cs <- 400 # specialty care
Cp <- 1350 # primary care
```

Prepare inputs for the ODE system integration and computation of outcomes for a given strategy: initial conditions, parameter values, costs, and outcomes. For the base case analysis, use marginal means of the joint distribution of model parameters. Inputs to the function 'ode.mod.inputs.means' are: a sample from the joint distribution of model parameters (joint), location code (city), OAT capacity at the specialty and primary care that define the strategy (Cs and Cp), periods per year (ppy), and the variable setting the value for the chosen scenario with respect to the structural modeling assumptions (rates). The function 'ode.mod.inputs.means'

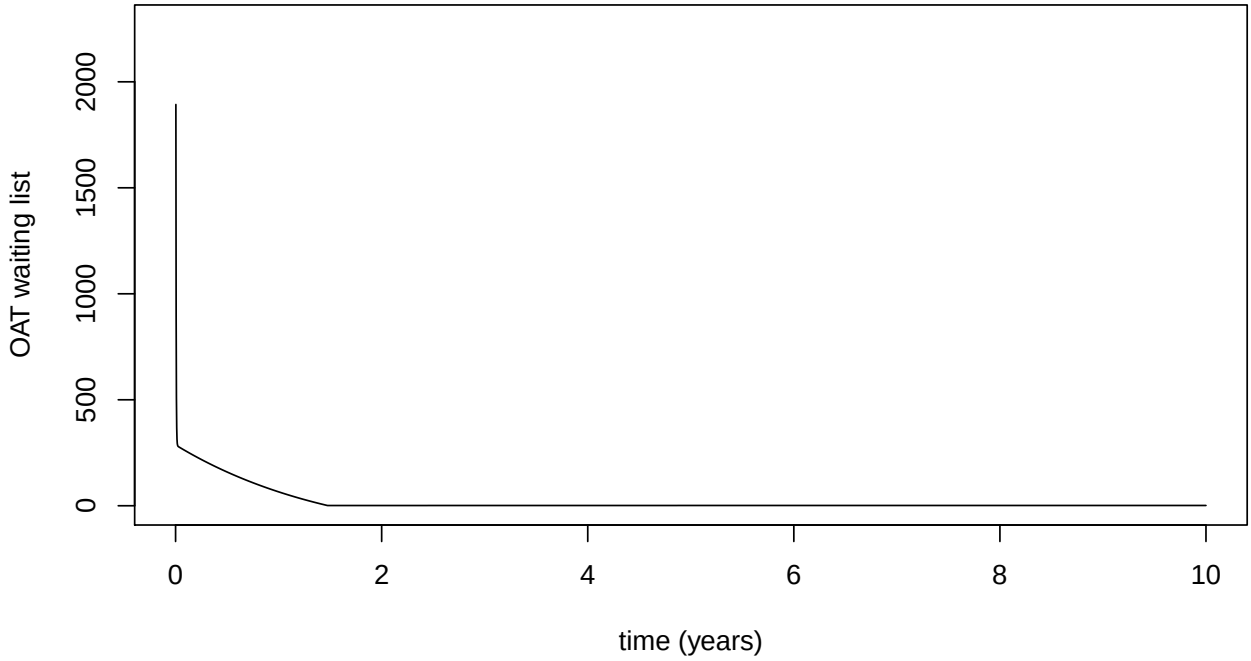
returns a list of point estimates of initial conditions, parameter values, costs, health utility weights, injection frequency, and the discount rate.

```
inp <- ode.mod.inputs.means(joint, city, Cs, Cp, ppy, rates)
state0 <- inp[[1]]
params <- inp[[2]]
coef.costs <- inp[[3]]
coef.qaly <- inp[[4]]
coef.inj <- inp[[5]]
r <- inp[[6]]
```

Integrate the system of ODE that determines the process dynamics. The function 'ode.int.detail' returns detailed temporal system dynamics, and the function 'ode.int.sum' returns summary measures for a given combination of parameters.

```
out.temp.dyn <- ode.int.detail(state0, times, oat.model, params, coef.costs, coef.qaly, coef.inj, r, ppy)
```

```
plot(x=out.temp.dyn$times/365, y=out.temp.dyn$Q, type='l', xlab='time (years)', ylab='OAT waiting list',
     ylim=c(0, 1.2*max(out.temp.dyn$Q)))
```




```
out.sum <- ode.int.sum(state0, times, oat.model, params, coef.costs, coef.qaly, coef.inj, r, ppy)
kable(out.sum)
```

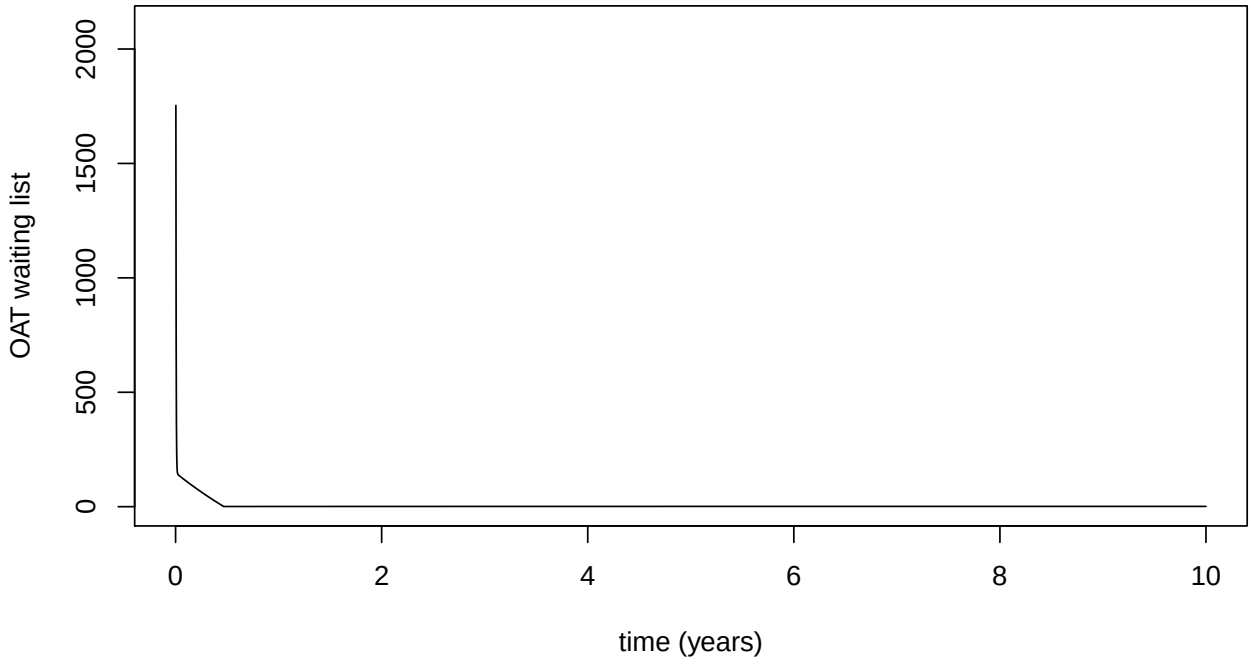
	x
CS	400
CP	1350
modeling.horizon	10
capacity.utilization.end	0.93
OAT.coverage.end	0.168
total.cost	5337242
total.qaly	515757
total.injections	30849249
total.drug.use.initiations	7854

Use the function 'ode.mod.inputs.draw' to compute the modeling results for a given draw from the sample of a joint distribution of model parameters. Inputs and outputs of this function are the same as those of 'ode.mod.inputs.means' with the exception of one additional input being a line number corresponding to a draw from the sample.

```
inp <- ode.mod.inputs.draw(joint, j=1, city, Cs, Cp, ppy, rates)
state0 <- inp[[1]]
params <- inp[[2]]
coef.costs <- inp[[3]]
coef.qaly <- inp[[4]]
coef.inj <- inp[[5]]
r <- inp[[6]]
```

```
out.temp.dyn <- ode.int.detail(state0, times, oat.model, params, coef.costs, coef.qaly, coef.inj, r, ppy)
```

```
plot(x=out.temp.dyn$times/365, y=out.temp.dyn$Q, type='l', xlab='time (years)', ylab='OAT waiting list',
     ylim=c(0, 1.2*max(out.temp.dyn$Q)))
```




```
out.sum <- ode.int.sum(state0, times, oat.model, params, coef.costs, coef.qaly, coef.inj, r, ppy)
kable(out.sum)
```

	x
CS	400
CP	1350
modeling.horizon	10
capacity.utilization.end	0.77
OAT.coverage.end	0.155
total.cost	4283400
total.qaly	471789
total.injections	31874009
total.drug.use.initiations	7848