**Cost-Effectiveness Analysis of a Humboldt County Screening and Referral Program with a Patient Navigator to Improve Maternal and Infant Outcomes for Pregnant Women with Substance Use Disorder: Instructions and Documentation for the Excel Model**

**ONLY CHANGE VALUES IN CELLS HIGHLIGHTED IN ORANGE. RELATED VALUES WILL AUTOMATICALLY ADJUST.**

This Excel Model can be used to examine the costs, short- and long-term cost savings, and the impact on the number of women and infants free from the effects of Substance Use Disorder (SUD) from the implementation of a screening and referral program to identify pregnant women at risk for SUD during pregnancy and the use of a patient navigator to assist them with obtaining treatment for substance use and a range of social and economic services. The model examines the impacts on women using opioids and/or stimulants but not other substances such as cannabis and alcohol.

**The model has four worksheets:**

1. Decision Tree: A graphical depiction of the decision tree showing the pathways for the intervention compared with the current standard of care with no program in place.

2. Parameters: A table showing the costs and probabilities used in the model. Each variable gives values for opioid use, stimulant use, and for both. Only the cells highlighted in orange are direct inputs. All others are formulas. Changes to the orange cell will automatically change all other related values. Sources for all of the parameter values are given in the model documentation. **ONLY MAKE CHANGES TO THE ORANGE CELLS.**

3. Results: Results are given for pregnant women using either opioids or stimulants. The first and second columns give:

- the number of infants and mothers who are positive for substance use at birth,
- the combined program and treatment costs,
- the combined short- and long-term health, social, and economic costs associated with pregnancy, the birth, and the infants' short- and long-term costs after birth

The third column gives the results of the analysis. These include the additional number of substance free infants and mothers at birth that resulted the intervention, the added program costs—including the cost for treatment for SUD—for the intervention, the savings in short-and long-term health care and other costs, that result from the intervention, and the net costs of the intervention compared to no intervention (additional program costs – health care and other costs savings = net costs), and the incremental cost effectiveness ratio (net cost/additional substance free mother infant pairs).

4. Calculations: This sheet shows all of the decision tree calculations that were performed to achieve the results shown on Worksheet 3.



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**How to Use this Excel Model**

You can use this model to test out different parameter values that the ones shown on Worksheet 2. You might do this to model a different situation. You can also try the model for a range of values around a parameter to discover how changes in values affects the results. This is especially useful for parameters where the values are not known and you are using a "best guess". This is called sensitivity analysis. **ONLY CHANGE VALUES IN CELLS HIGHLIGHTED IN ORANGE. RELATED VALUES WILL AUTOMATICALLY ADJUST.**

**Some Suggested Uses for the Model**

1. Examine the costs and impact of a screening and referral program with a patient navigator in a specific setting, such as an FQHC. Change the size of the cohort (B38) to the number of pregnant women screening in the specific setting. Change any other variables that may also change, such as probability of screening positive (B5) (based on prevalence of pregnant women using opioids or stimulants) and the costs for screening (B29) and the patient navigator (B30).

2. Examine how costs and outcomes may change if the prevalence of drug use among pregnant women changes. Modify the Probability of Screening of Positive with the 4P tool (B5). The value is equivalent to prevalence in this version of the model.

3. Determine the costs of the screening and patient navigator program for a specific cohort. Select the cohort size for your setting. Set the Cost of Treatment for Substance Use (B31) to $0. The Program Costs line on the Results tab now only includes those costs.

4. Examine costs that occur over 12-18 months of project. Set Long-Term Costs (B36) to $0.

5. Examine costs over 5 – 10 years. The long-term annual health and social costs for a substance affected infant range from $7,500 to $30,000. Select a number and multiply by number of years for analysis. (E.g. $7,500 x 10 years = $75,000). Enter in Long-Term Cost cell (B36).

**For further information or comments on this model contact:**



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**Model Documentation**

**Methodology and Data**

**Analytic Method** - We conducted a cost effectiveness analysis of a drug use screening and referral program for pregnant women in Humboldt County. We examined the costs, savings, and effectiveness of an intervention that would reduce the number of mothers and infants with SUD. We compared the costs of the intervention and subsequent costs for drug treatment with the savings in health care, social, and economic costs associated with SUD births. We specifically examined the impact on pregnant women using opioids or stimulants. We did not examine the impact on women using cannabis, alcohol, or other substances.

**Cohort** - The cohort for the analysis were all pregnant women in Humboldt County who initially seek care in a one-year period. Based on the number of births in previous years, the estimated cohort size was 1,500 women.

**Time Period** – This analysis considered the costs and benefits of a prenatal screening and referral program for a cohort of pregnant women in Humboldt County screened during a one-year period. The analysis follows the cohort through their pregnancy and early postpartum period for mothers and their infants. The long-term analysis captured the estimated lifelong health, social, and economic impacts associated with SUD infants born to this 12-month cohort of women.

**Perspective** – This analysis takes the societal perspective and captures all of the costs and benefits regardless of who pays for them or who receives them.

**Model** – We developed a decision tree and cost effectiveness model using Excel.

**Intervention Description**

The intervention for this analysis consists of three components: 1) initial screening using the 4Ps tool and referral to a patient navigator if needed, 2) the services of the patient navigator, and 3) drug treatment and social services. Although all pregnant women received the first component, only a limited number utilized the services of the patient navigator and subsequently sought treatment for their substance use.

In Humboldt County, pregnant women would be screened and referred to a community-based patient navigator for secondary screening and assistance in the following settings:

- Prenatal practices
- Hospital EDs and outpatient clinics
- Family Resource Centers
- Family Wellness Court (a collaboration of the Superior Court of Humboldt County and the Yurok Tribal Court)

**Screening Tool Description and Validity**

The screening step in this intervention uses the 4Ps tool. It should be noted that the 4P tool does not screen for substance use, it identifies pregnant women at higher risk for substance use disorder (SUD). A pregnant woman can screen positive if her partner has SUD, decline to see a patient navigator and receive treatment, but still have a good birth outcome. Other women who are not using drugs but screen positive may choose to see a patient navigator and avail themselves of social services referrals.

Patients who score a yes to any of the four questions in the screening test are referred to the patient navigator for secondary screening and referral to appropriate services as deemed useful.

Below is a description of the 4P tool taken from the Indian Health Service.
https://www.ihs.gov/sites/opioids/themes/responsive2017/display_objects/documents/4Pscreeningtoolhowto.pdf

The 4Ps stand for Parents, Partner, Past, and Present. To conduct the 4Ps Screening ask:

- Parents: Did any of your parents have problems with alcohol or other drug use?
- Partner: Does your partner have a problem with alcohol or drug use?
- Past: In the past, have you had difficulties in your life because of alcohol or other drugs, including prescription medications?
- Present: In the past month, have you drunk any alcohol or used other drugs?

  Scoring: Any “yes” should trigger further questions.

  - Document a “yes” to each question individually.
  - Document a “negative” if all answers are “no.”

The 4Ps tool is not copyrighted and is free to use. The 4Ps PLUS tool is copyrighted and there is a fee to use. More information can be found at:

Ewing H. A practical guide to intervention in health and social services with pregnant and postpartum addicts and alcoholics: theoretical framework, brief screening tool, key interview questions, and strategies for referral to recovery resources. Martinez (CA): The Born Free Project, Contra Costa County Department of Health Services; 1990.

https://www.acog.org/Clinical-Guidance-and-Publications/Committee-Opinions/Committee-on-Obstetric-Practice/Opioid-Use-and-Opioid-Use-Disorder-in-Pregnancy?IsMobileSet=false

**Screening Tool Validity**

| | |
|---|---|
| Sensitivity | 0.80 |
| Specificity | 0.83 |
| Positive predictive value (PPV) | 0.50 |
| Negative predictive value (NPV) | 0.95 |

**Patient Navigator**

Patient Navigators – The current patient navigator is an outpatient hospital service paid for from its community benefit fund. There is also a patient navigator at one of the tribal clinics. Other providers are considering using patient navigators. This model assumes that all providers and referral agencies in the county have access to a patient navigator.

The patient navigator can refer clients for SUD treatment of a variety of kinds including detoxification, inpatient and outpatient treatment, and pharmacological management. The patient navigator can also make referrals to services for:

- Housing
- Family support
- Domestic violence
- Childcare
- Vocational training
- Food security
- Financial counseling

**Treatment for Drug Use**

Treatment – Treatment for drug use in this analysis falls into four categories: initial detoxification which may involve inpatient treatment, residential treatment, outpatient treatment, and the ongoing costs for pharmacological management. A pregnant woman may avail herself of one or more of these services. For example, a pregnant woman may go to detoxification first and then to a 90-day inpatient program and continue with outpatient treatment and pharmacological management. Many pregnant women receive pharmacological management or medication-assisted treatment (MAT) throughout pregnancy. MAT, including opioid treatment programs (OTPs), combine behavioral therapy and medications to treat substance abuse. In our model, women using MAT are designated as substance free at the time of birth. However, their infants are designated as positive for substance use because of the additional health care required.

In our model, we only included pregnant women referred to the patient navigator and entering drug treatment who were using either opioids or stimulants such as methamphetamines. Opioid and stimulant use are seen together with increased frequency but data on treatment cost and effectiveness is limited and more difficult to model. There are more effective treatments for opioid use than for methamphetamine and poly use and treatment success rates

are higher for opioid use disorder than for stimulant use. We also did not include women sing other drugs or alcohol.

**Outcomes**

This analysis considers three sets of outcomes: infant outcomes, maternal outcomes, and infant maternal pairs. Infants and mothers are considered either substance free or positive for substance use at the time of birth.

**Infant Outcomes**

We examined the short and long term medical, social, and economic outcomes for infants with in utero exposure to stimulants or opioids. Infants with in utero exposure to opioids or methamphetamines are at higher risk for low birthweight, premature birth, and low head size. Infants often require an eat/sleep/console type of intervention. Because of the risks of withdrawal, infants who test positive for substance use could be placed in the NICU or have prolonged placement in the hospital nursery. This may also require pharmacological intervention. Social services issues including the mother's incarceration, drug treatment, or foster care placement may also result in an extended hospital stay.

Immediate issues from birth through the first two weeks include failure to thrive, increased medical intervention, and more frequent follow up after discharge. There is also the risk that the infant will have contracted Hepatitis C or HIV infection during the pregnancy.

Infants are also likely to experience longer term health and social issues. There is a lower risk of certain long-term health issues in infants born with opioid exposure than those born with stimulant exposure. Infants exposed to stimulant use during pregnancy are at a higher risk of birth defects including congenital heart problems.

Long-term social outcomes may include loss of custody and foster care placement, ACES, lower school achievement, long-term employment, juvenile justice issues, and truancy. These outcomes are quantified, to some extent, through the estimates for log term costs (see Costs below).

**Maternal Outcomes**

We created two categories of maternal outcomes: mothers positive for substance use and substance free mothers. Unlike the infant outcomes, we categorized mothers utilizing pharmacological management as substance free. We chose this category because we assumed that the women did not need additional health care after giving birth and would be able to care for their infant. This lowers the risk of incurring social services costs and long-term health care, social, and economic costs for their child. We did not capture any future social, economic, and health costs for the mothers.

Maternal mortality, incarceration, and postpartum suicide are also not included because of lack of data on both probability and cost. Women with SUD who become pregnant and give birth without addressing their substance use are at higher risk for all three outcomes, all of which also have serious consequences for short- and long-term infant outcomes.

**Mother Infant Pairs**

We further structured the maternal and infant outcomes into three mother infant pairs. We did this because we assumed that the future health and wellbeing of the infant depended in large part upon the psychological, physical, social and economic health of the mother, influenced by her substance use status. The three pairs were:

1. Infant test positive for substance use–mother positive for substance use: Pregnant woman continues drug use, either not obtaining or not successfully completing drug treatment. Mother and infant test substance-affected.
2. Infant test positive for substance use– substance free mom: Pregnant woman successfully completes treatment or voluntarily stops drug use without treatment. Infant tests positive for substance use due to mother's MAT or drugs still in system at time of birth. Mother and infant test substance-affected but mother categorized as substance free.
3. Substance free infant – substance free mom: Pregnant woman either not using drugs or stops using drugs prior to delivery. Mother and infant test substance free.

We assumed that the infant who tests positive for substance use born to a substance free mom represented an infant born to a mother who had either recently stopped drug use or was undergoing pharmacological management for her addiction. We assumed that this might affect the infant's health status at birth, possibly a problem delivery, and an additional hospital stay including time in the NICU. We also assumed that the mother would be able to care for her child and the child would avoid long-term consequences of having a mother with SUD.

**Cohort size** – We used a cohort of 1,500 pregnant women seeking services in Humboldt County. The estimate was based on the following data. There were 1,410 births in Humboldt County in 2019: Mad River Community Hospital (612), St. Joseph Hospital (489), Redwood Memorial Hospital (244), birthing center (20), home residence (37), and other (8).

**Probabilities**

**Probability of drug use among pregnant women (prevalence)** – We used data from hospital births in Humboldt County to estimate this probability. We calculated the probability of opioid use, stimulant use, and a combined probability. A description of the data follows:

There are three hospitals in Humboldt County with Labor & Delivery departments. Two hospitals screen for substances universally, one screens selectively based on risk factors. In

2019, of 314 births at the three hospitals (not all births at these hospitals as reporting varied), 18 infants screened positive for opiate use, 2 for benzo use, 17 for stimulant use, and 4 for barbiturate use. Forty-four screened positive for cannabis use. Twenty-one infants screened positive for buprenorphine and methadone use, two drugs used to treat substance use disorders. Twenty-seven percent of births were positive for substance use and 13 percent were positive for non-cannabis substance use.

**Probability that patient accepts care navigator** – Best guess. We had very limited information on number of pregnant women screened and referred to a patient navigator but no information on the number of women actually seen by the patient navigator. We also had some information on the service level in the referral. Over a twelve-month period, from July 2019 thru June 2020, there were 93 referrals to the Community Based CARE Navigator.

**Other probabilities** – We had no data from which to estimate the following probabilities and used a best guess. Probability that:

- Pregnant woman enters drug treatment
- Pregnant woman in drug treatment stops drug use
- Pregnant woman voluntarily stops drug use
- Problem delivery due to drug use
- Substance-affected infant in NICU
- Substance-affected infant has birth defects
- Substance-affected infant needs social services at birth
- Substance-affected infant has long term health, social, and economic needs

**Costs**

The costs in this analysis are those for the screening and referral program, the costs of treatment for opioid and stimulant use, and the short- and long-term health care, social, and economic costs for infants who are positive for substance use at birth. I had very limited data for costs in Humboldt County so have drawn on the literature for approximations. All costs in this model are in 2020 US dollars.

**Costs of the Screening and Patient Navigator Program**

I had very limited information on per patient charges for the initial screening and referral costs so have taken estimates from similar programs. Here are some known local costs for the screening program and the patient navigator. Table 2 provides information on the local startup and ongoing costs of a pilot screening and referral program with a patient navigator.

I used a $50 screening costs for the time to implement the 4P screening tool, record responses in patient charts, and make referrals to the patient navigator when appropriate. I used a $250 per referral cost for the patient navigator. Based on the information provided from Humboldt county, including data showing that for a 12-month period in 2019 and 2020 the patient

navigator received 93 referrals, I estimate that the per patient cost for the patient navigator would be $1,410. If the patient navigator saw 500 referrals a year, the number of referrals estimated for the entire county for all pregnant women using toxic substances during pregnancy (including cannabis) the per patient cost would be $262. Closer examination of the patient navigator is needed to determine how many referrals the patient navigator can see during a one-year period and whether the patient navigator works on other projects, thus reducing the FTE from 1 to a lower number.

**Cost of Drug Addiction and Treatment**

Treatment costs for drug addiction falls into four categories: initial cost of detoxification which may involve inpatient treatment, the cost of residential treatment, the cost of outpatient treatment, and the ongoing costs for pharmacological management or drug maintenance. A patient may incur expenses in one or more of these categories. Below is a summary of costs reported in the peer-review literature and from nonprofit organizations that address addiction.

Detoxification (detox) refers to treatment—usually inpatient—for the period in which the person's body is ridding itself of addictive substances. It can cost about $600 to $1,000 a day. American Addiction Centers. (2017). Detox can range from $300-$800 a day. https://www.recovery.org/drug-treatment/cost/

Basic residential treatment can range from $2,000 to $25,000. The cost of outpatient treatment, which can be in lieu of or following a residential program can range from free for the patient to $500 per session. https://www.recovery.org/drug-treatment/cost/

Though program costs will be variable, standard inpatient addiction treatment facilities can cost between $14,000 and $27,000 for a 30-day program. Substance Abuse and Mental Health Services Administration. (2015). *Insurance and Payments*.

Outpatient treatment can range from free to $500 per session. Substance Abuse and Mental Health Services Administration. (2015). *Insurance and Payments*.

Outpatient can range from free to $10,000. https://www.recovery.org/drug-treatment/cost/

Broome (2012) found that the average cost of 60-day treatment was $793 and $1,042 for 90 days in 2006. Broome KM, et al. Treatment program operations and costs. J Subst Abuse Treat. 2012: 42; 125-133.

Treatment also includes ongoing therapeutic drug maintenance. In 2013, 90 percent of Substance abuse disorder (SAD) patients under treatment incurred outpatient drug costs ranging from $21 per month to $1,000 per month. Benzodiazepines, used to treat anxiety and other symptoms in SAD patients, cost Medicare $190 per patient per year while methadone maintenance treatment costs are $4,700 per patient per year.

https://www.drugabuse.gov/publications/principles-drug-addiction-treatment-research-based-guide-third-edition/frequently-asked-questions/drug-addiction-treatment-worth-its-cost

Another approach to estimating the cost of SUD treatment is to examine the differences in health care costs for persons who experience and do not experience SUD. Some studies that have taken this approach also report average costs for a broad treatment category. The estimate used in this analysis draws on this approach. Although we had a range of costs for various types of treatment, we had no information on the percent of people seeking which type of treatment or who utilize certain combinations of services for what periods of time. The excess cost approach does not appear to be inconsistent with costs reported for specific services.

One study found that persons with SUD who are covered by Medicaid have higher health care costs than persons who do not experience SAD. Their costs are $14,779 per patient per year higher. Young K, Zur J. Medicaid and the opioid epidemic: enrollment, spending, and the implications of proposed policy changes. The Kaiser Family Foundation Issue Brief, 2017. http://files.kff.org/attachment/Issue-Brief-Medicaid-and-the-Opioid-Epidemic-Enrollment-Spending-and-the-Implications-of-Proposed-Policy-Changes

According to the Partnership to End Addiction, a person with opioid addiction has an extra $2,391 in health care costs and $2,425 in behavioral health care costs. The organization notes that persons who are opioid addicted have a higher risk of Hepatitis C and HIV and the associated health care costs. https://drugfree.org/drug-and-alcohol-news/addiction-costs-medicaid-hundreds-of-millions-annually-study-says/#

In 2013, Leslie, et al. found that persons with Opioid Use Disorder had $6,485 higher health care costs. Almost 30 percent of the excess cost ($3,554) was for treatment costs and $2,930 for nontreatment health care costs. Leslie D, et al. The economic burden of the opioid epidemic on states: the case of Medicaid. Am J Manag Care. 2019;25:SO.

In 2008, a Mathematica study showed that it costs on average $3,000 to treat SAD or $3.4 billion for 1.1 million service uses. Bouchery E, et al. Medicaid substance abuse treatment spending: findings report. Mathematica Policy Research. Washington DC, 2012.

These last three estimates of the average cost of treatment for opioid abuse and substance abuse disorders, when converted to 2020 dollars range from $3,425 to $4,392. (Medical services component of the Consumer Price Index, 1935-2020. U.S. Bureau of Labor Statistics). I used an estimate of $4,000 for the cost of drug treatment in the model. I used this estimate for treatment of both opioid and stimulant use.

**Short-Term Additional Health Care and Social Services Costs**

Short-tern additional health care and social services costs include a number of components: health care costs for the mother during and immediately after pregnancy, health care costs associated with the birth, health care costs for the infant during the first few weeks of life, and social services costs associated with infants who test positive for substance use born to mothers with SUD. Again, because of the lack of data on local costs and health care practices, we used estimates from the literature.

I examined two studies that compared the pregnancy-related costs for women with SUD with women who were not using substances. Additional costs ranged from $3,668 (2020 US$) (Whiteman 2014) to $12,710 (2020 US$) (Goler 2012). These included hospital costs during pregnancy and costs related to the pregnancy and delivery.

I also examined costs associated with Neonatal Abstinence Syndrome (NAS). One study found that 27% of infants born to women using opioids during pregnancy had NAS. The excess health care costs related to NAS ranged from $13,763 to $78,847 (2020 US$). When included as 27% of births to women using drugs during pregnancy, excess health care costs for infants ranged from $$3,801 to $21,289 (2020 US$).

For this analysis I picked a midpoint among the studies and used the estimate of $12,710 (2020 US$) from the Kaiser Permanente Northern California Early Start program analysis (Goler 2012).

A description of each of the studies follows.

A 2012 cost benefit analysis of the Early Start program implemented by Kaiser Permanente Norther California found that there was a $9,000 (2009 US$) ($12,710 2020 US$) mean difference in short term birth-associated costs between women who screened positive for substance abuse compared with a control group. These costs included costs of ED visits, costs associated with the birth and costs associated with the treatment of preterm infants. Goler et al. Early Start: a cost-benefit perinatal substance abuse program. Obstetrics & Gynecology. 2012; 119:102-110.

On average, woman who used opioids during pregnancy had $2,597 (2009 US$) ($3,668 2020 US$) higher hospital costs than women who did not. Women who used opioids had higher rates of depression, anxiety, and chronic medical conditions and were more likely to experience threatened preterm labor, early onset delivery, poor fetal growth, and stillbirth. These women were four times more likely to have a prolonged hospital stay and four times more likely to die before discharge. Whiteman VE, et al. Maternal opioid drug use during pregnancy and its impact on perinatal morbidity, mortality, and the costs of medical care in the United States. J Pregn, 2014. http://dx.doi.org/10.1155/2014/906723

**Excess health Care Costs for Infants born with NAS/Infant drug exposure**

82% of NAS-related births were covered by Medicaid in 2014 and cost $462 m. Winkleman TNA, et al. Incidence and cost of neonatal abstinence syndrome among infants with Medicaid: 2004-2014. Pediatrics. 2018. 141(4) e20173520; DOI: https://doi.org/10.1542/peds.2017-3520

In 2012, full-term infants with no health complications accrued a mean cost of $3,500 in hospital expenditures at birth. Infants with Neonatal abstinence Syndrome (NAS) have a hospital stay eight times the length of health infants and accrue healthcare expenditures nineteen times more than their healthy counterparts (meant hospital charge of $66,700). Ko J, Wolicki S, Barfield W, Patrick S, Broussard C, Yonkers K, Naimon R, Iskander J. CDC Ground Rounds: Public Health Strategies to Prevent Neonatal Abstinence Syndrome. *Weekly CDC Online Publication*. 2017. 66(9); 242-245

2016, 74% of births infants with NAS or non NAS drug exposed were on public insurance. NAS additional $12,328, non NAS drug exposed additional $517. (cost of normal birth $2,052) Cost US over $1b in 2015. Of drug exposed births 27% are NAS, 73% are non NAS drug exposed. Myers, Matthew G, "Economic Burden of Infant Drug Exposure in Texas" (2018). *Texas Medical Center Dissertations (via ProQuest)*. AAI10789532. https://digitalcommons.library.tmc.edu/dissertations/AAI10789532

Infants born with NAS had 16.57 hospital days ($16,893) compared to 4.98 for non NAS ($5,610). 2012$. Corr TE, Hollenbeak CS. The economic burden of neonatal abstinence syndrome in the United States. Addiction. 2017;112:1590-1599.

NAS costs over $50,000 per infant for neonatal care. Higher NAS rates were linked to high long-term unemployment rates especially in rural counties. Patrick, S. W., Faherty, L. J., Dick, A. W., Scott, T. A., Dudley, J., & Stein, B. D. (2019). Association Among County-Level Economic Factors, Clinician Supply, Metropolitan or Rural Location, and Neonatal Abstinence Syndrome. JAMA, 321(4), 385-393.

Special education costs 2 times regular education per child. 20% of NAS required special education. In 2017 the additional annual cost for special education was $15,341 in Pennsylvania and $22,593 in NY. Morgan PL, Wang Y. The opioid epidemic, neonatal abstinence syndrome, and estimated costs for special education services. Am J Manag Care. 2019; 25:-SO

**Long-Term Health, Social, and Economic Costs**

To examine the long-term impact of the screening and referral program, I included an estimate for lifetime costs associated with a substance-affected birth. These would include health, economic, and social costs. SUD lifetime or long-term costs were not available in the published literature. The closest approximation were lifetime costs for Fetal Alcohol Syndrome.

Lifetime FAS costs in 2011, were estimated to be $1.987 million for medical costs, special education, residential care and $0.497 million in productivity losses for $2.484 million in total costs. (2020 $2.87 million) O'Brien ML, Phillips SM. Substance exposed newborns: addressing social costs across the lifespan. Issue Brief No. 40. The Massachusetts Health Policy Forum, 2012.

A Canadian study estimated costs for direct costs including medical, education, social services, and out-of-pocket costs; and productivity losses. Total average costs per individual with FASD were calculated by summing the costs for each in each cost component, and dividing by the sample size. Costs were extrapolated to one year. A stepwise multiple regression analysis was used to identify significant determinants of costs and to calculate the adjusted annual costs associated with FASD. Total adjusted annual costs associated with FASD at the individual level was $21,642 (2007 Can$) ($29,868 2020 US$). Severity of the individual's condition, age, and relationship of the individual to the caregiver (biological, adoptive, foster) were significant determinants of costs. Cost of FASD annually to Canada of those from day of birth to 53 years old, was $5.3 billion. Stade B, et al. The burden of prenatal exposure to alcohol: revised measurement of cost. Can J Clin Pharmacol. 2009; 16:e91-102. CPI Calculator, U.S. BLS.

**Limitations**

This model presents a conservative estimate of the cost-effectiveness of screening, referral, and treatment of pregnant women with SUD. The study has many limitations due to the need to reduce the complexity of the model and the lack of data on many probabilities, costs and outcomes for women and their infants. Almost all of these limitations, if addressed in the model, would result in additional cost savings. A list of key limitations follows:

The model does not explicitly incorporate the sensitivity and specificity of the 4P screening tool. Although sensitivity and specificity has been reported in the literature, I did not have other data needed to explicitly factor this in. However, the number we used for the probability of women screening positive for risk of substance use produces the observed number of infants who test positive for substance use at birth (from Humboldt County hospital data) in the baseline scenario.

Key information regarding the patient navigator was not available including the number of patients that the patient navigator sees each year, the type of substance abuse, and the type, number and results of the referrals. This information affects both the costs and the effectiveness of the intervention and, thus, the model's results.

I had no information of the types of drug treatment, cost, and effectiveness sought by pregnant women. I also had no information for treatment information by type of substance use. I used averages from the literature for treatment paid for primarily by Medicaid. This may affect both cost and effectiveness results.

I did not consider cannabis use during pregnancy in this analysis. Although cannabis use appears to be rising in many areas, its impact on infant and maternal outcomes is less well known. Additionally, data on cannabis use and in utero infant exposure is not readily available. Long term social impacts may not be as severe as those from opioid and stimulant use. Women in California are less likely to be incarcerated for cannabis use or lose custody of their children.

No set of maternal and infant outcomes are as cut and dried in reality as they are for this model. For the ease of modeling we had to create discrete outcomes and outcome pairs. We did not include the impact of future substance use by the mother. We did not explore the variety of living situations an infant born to a mother with SUD might experience. We did not attempt to quantify childhood ACES and count their costs, although they are implicitly included in the long-term cost estimate. In addition to the complexity this would bring to the analysis, I simply do not have data to allow this. Therefore, I have listed a range of possible outcomes and assigned a lifetime cost. This cost was taken from analyses of children born with fetal alcohol syndrome, the closest we could achieve for approximating maternal opioid or stimulant use. To adjust for this, I conservatively assumed that infants would accrue only 25 percent of these future costs or that the lifetime costs of Fetal Alcohol Syndrome are greater than those for a substance-affected infant.

I did not include any future social, economic, and health costs for the mothers. This would improve the cost savings and cost effectiveness of the model. Benefits to women who stop substance use might include:

- Reduced drug-related crime
- Reduced criminal justice costs including $24,000/year incarceration cost
- Reduced theft
- Fewer drug-related accidents
- Decreased domestic violence
- Increased workplace productivity

This is only a partial list of the limitations.

Table 1. Base Case Probabilities and Costs for Humboldt County Cost-Effectiveness Analysis of a Screening and Referral Program with a Patient Navigator to Improve Maternal and Infant Outcomes for Pregnant Women with SUD

| **Humboldt County Screening and Referral Program for Pregnant Women Using Drugs** | | | |
|---|---|---|---|
| **12 Month Program** | | | |
| | | | |
| **Probabilities** | Opioid Value | Meth Value | Combined |
| Screens positive with 4P tool | 0.14 | 0.05 | 0.19 |
| Patient referred to and accepts navigator | 0.7 | 0.7 | 0.70 |
| Patient enters drug treatment | 0.7 | 0.7 | 0.70 |
| Patient completes drug treatment | 0.6 | 0.3 | 0.52 |
| Patient voluntarily stops using substances | 0.2 | 0.1 | 0.17 |
| Patient voluntarily enters drug treatment | 0.25 | 0.25 | 0.25 |
| Problem delivery due to substance use | 0.5 | 0.5 | 0.50 |
| Substance-affected infant in NICU | 0.5 | 0.5 | 0.50 |
| Substance-affected infant has birth defects (meth only) | 0 | 0.02 | 0.01 |
| Social services at birth | 0.8 | 0.8 | 0.80 |
| Long-term effects in substance-affected infant | 1 | 1 | 1.00 |
| | | | |
| **Costs** | | | |
| Cost of 4P Screening and Referral | $50 | $50 | $50 |
| Cost of Patient Navigator | $200 | $200 | $200 |
| Cost of Treatment for Substance Use | $4,000 | $4,000 | $4,000 |
| Extra Cost of Problem Delivery | $0 | $0 | $0 |
| Extra Costs associated with Drug Affected Delivery | $12,710 | $12,710 | $12,710 |
| Cost of social services at birth | $1,000 | $1,000 | $1,000 |
| Long term health care costs of birth defects | $0 | $0 | $0 |
| Long term social services cost | $500,000 | $500,000 | $500,000 |
| | | | |
| **Target Population Size** | 1500 | 1500 | 1,500 |

Table 2: Humboldt County Patient Navigator Program Costs, 2019

| **Screening and Referral and Patient Navigator Cost** | | |
|---|---|---|
| | | |
| **Startup costs** | | **Notes** |
| Training per Office | | |
| Personnel time | | |
| Perinatal SUD Project Manager | $270 | Eight hours with prep, correspondence |
| Medical Director | $294 | Three hours with prep and training |
| Perinatal SUD Project QI Lead | $259 | Eight hours prep, training, follow-up |
| Stigma and ACES Trainer | $120 | $40/ hour 3 hours (prep and training) |
| Office Staff Time for MAS | $203 | $27/hr. rate (salary and benefits) |
| Office Staff Tim for Office Manager | $113 | $38/hr. rate (salary and benefits) |
| Printed Training Materials | $25 | |
| Lunch | $120 | 10 individuals |
| **Total Training Cost** | **$1,404** | |
| | | |
| **Ongoing Screening Costs** | | |
| Screening Material | **$70** | 1,000 paper screening tools w/ carbon copies |
| | | |
| **Patient Navigator** | | |
| **Startup Costs** | | |
| mobile devices and equipment | **$6,000** | one-time expense |
| **Ongoing Costs** | | |
| Personnel | | |
| 1.0 FTE Care Navigator | $78,000 | salary plus benefits |
| 0.2 FTE Care Navigator Manager | $21,840 | salary plus benefits |
| ACT.md Licenses for Staff | $1,680 | $70/user per month 12 months; 2 users |
| Patient expenses | $6,000 | |
| Local Mileage | $3,600 | |
| **Total PN Ongoing Costs** | **$111,120** | |