IOSR Journal of Mathematics (IOSR-JM)
e-ISSN: 2278-5728, p-ISSN: 2319-765X. Volume 16, Issue 6 Ser. III (Nov. – Dec. 2020), PP 16-27
www.iosrjournals.org

Modeling and Analysis of Drug Spread System

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***Abstract*：** *The spread crisis of opioid drugs has brought serious influence to American society. How to effectively control the spread of opioid drugs has become the focus of attention of government. Fortunately, differential equation propagation model provides us new ideas to deal with it. First, by analyzing the data in " NFLIS_data", we find that the spread trend of opioid drugs in different states is different with time. From a spatial point of view, opioid users are mostly distributed in the border areas of various states and have certain spread effects on the surrounding counties. Next, according to the drug spread mechanism, a differential equation model (Model 1) is established. Using this model, combined with data analysis, the possible spread sources of fentanyl in five continents are screened. Two counties, PHILADELPHIA and HAMILTON, are selected to predict the time when heroin spread reaches the threshold state. We find that the spread of heroin in HAMILTON county shows a convergence trend. while in PHILADELPHIA county, it shows a spread trend. Opioid is spreading in both counties. In addition, we have given the government's concerns. Then, five socio-economic index data of five counties are screened out, and the analysis found that the socio-economic index had a strong correlation with drug spread. Model 1 was improved (Model 2). Through case analysis, the prediction data of Model 2 are better than Model 1. Also, in order to help the United States alleviate the drug crisis, we put forward some coping strategies and quantified these factors to obtain a constrained differential equation model (Model 3). By analyzing the quantitative indicators, we have obtained the important parameter limits to slow down the spread of drugs. Finally, taking the spread of HENDERSON heroin as an example, the effectiveness of the strategy is tested. Compared with the number of spread before and after government control, the number of spread is smaller than that required by Model 2. It further verifies the effectiveness of the policy. That is, the strategy given in this paper has important guiding significance for alleviating the drug crisis in the United States.*

Keywords: *Data analysis; Drug Spread System; Differential equation model*

Date of Submission: 22-11-2020 Date of Acceptance: 07-12-2020

I. Introduction

Opioid drugs are natural or synthetic compounds, which can produce different effects such as complete excitation, partial excitation, excitation and antagonism by combining with one or more opioid receptors in the peripheral and central nervous system. It can inhibit the generation and spread of nociceptive incoming signals and produce analgesic effects. Since 2000, more than 300,000 people have died of opioid overdose in the United States [1]. Preliminary data for 2016 shows that at least 64,000 people died of drug overdose. It set a new record [2]. These are all caused by the abuse of opioid drugs. Federal agencies such as the United States Centers for Disease Control (CDC) are trying to save lives and prevent the epidemic from having negative effects on health.

In this paper, we break our work into sections as follows.

Task 1. Describe the spread characteristics of opioid drugs and heroin incidents among the five states (counties) by establishing a model. Identify any possible locations in the five states where specific opioid drugs will begin to be used. How worried will American government be if it continues? At what drug identification threshold levels do these occur? Using our model to predict when and where they will occur?

Task 2. Based on the socio-economic data provided by the US census, we can improve the model in Task 1.

Task 3. Combining the results of Task 1 and Task 2, we will propose possible strategies to deal with the opioid crisis. We use the model to test the effectiveness of this strategy and determine the important parameter limits on which success depends.

Overview of work:

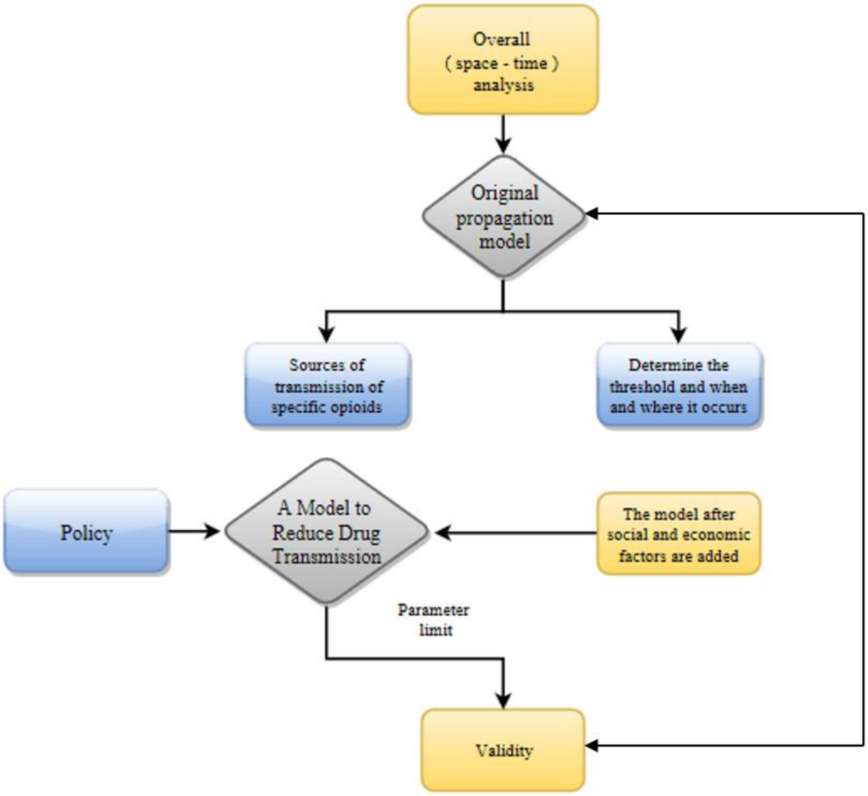

Figure 1: General flow chart

II. Assumptions and Justification

◆ **Assumptions I:** The total number of people in the investigated area during the drug spread period N remains unchanged, neither considering life and death nor migration.

Reason: It can make the research more convenient.

◆ **Assumptions II:** People are not immune to opioid and heroin drugs.

Reason: The model needs to involve the cure rate of drugs.

◆ **Assumptions III**: The number of cases equals the number of people taking drugs.

Reason: The number of cases is not necessarily related to the number of people taking drugs.

◆ **Assumptions Ⅳ:** Assume that drug users are evenly distributed.

Reason: An idealized distribution state can provide convenience for subsequent calculations.

III. Symbols and Meanings

In the section, we use some symbols for constructing the model as follows:

Table 1: Symbols and Meanings

Symbols	Meanings
i	Number of drug users
t	Time
σ	The number of spread
λ	Spread rate
a_1	Coefficient of unmarried female
a_2	Coefficient of single parent families
a_3	Coefficient of less education
a_4	Coefficient of left-behind children

a_5	Coefficient of high school students
h_1	Number of unmarried female households
h_2	Number of single parent families
h_3	Number of families with less education
h_4	Number of families with left-behind children
h_5	Number of families with high school students
λ'	New spread rate
d	The limits of government control
s'	Response to post-policy spread

P.s. Other symbols instruction will be given in the text.

IV. The spread of opioid and heroin incidents

4.1 Data processing

Since the drugs contain non-synthetic opioids, we first screened out morphine and codeine. According to different states, we put the data into new Excel tables. Then, the data of among states are screened by year, and the number of cases of opioid drugs and heroin are summed up respectively. We get the total case value of two types of drugs in five states.

4.2 Supplementary Assumptions and justification

1. We assume that the total number of people in the area under investigation during the drug spread period, N will remain unchanged. We don't regard of life and death or migration. It will bring convenience to the following research.
2. It is assumed that people have no immunity to the drug during its spread. This part of people who take medicine to cure diseases may break away from these medicines after their condition improves. And they may take medicine again after they are healthy.

4.3 Drug spread characteristic and model

4.3.1 Description of the characteristics of spread

For the characteristics of spread, we adopt a combination of time and space to analyze.

First, we analyze the changes of the total cases of opioid and heroin in the "2019MCM Problem C Data.xlsx" in among states over time.

We make a graphic analysis of the total cases of opium and heroin in the five states of the United States. We can get the following five figures:

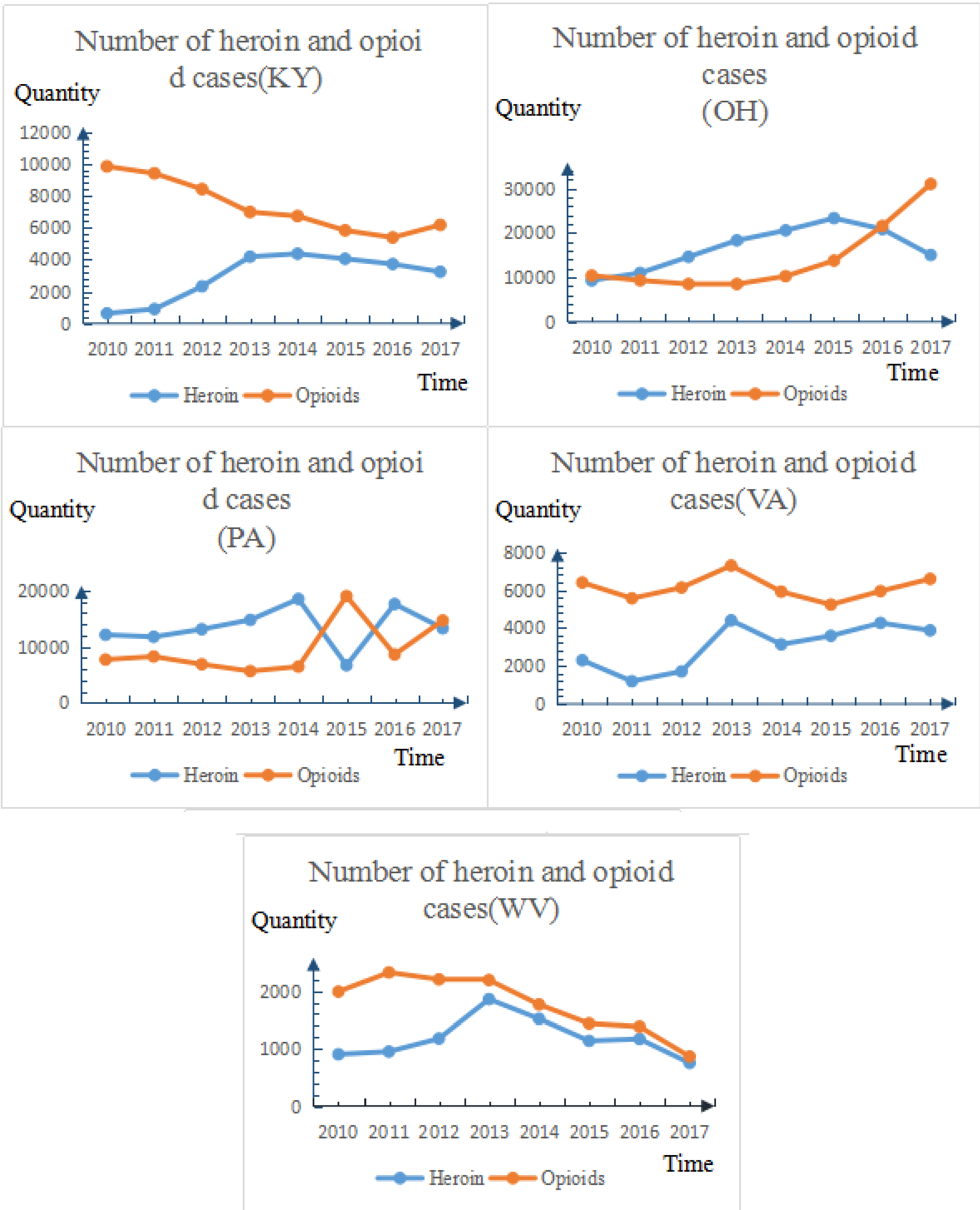

Figure 2: Trend chart of drug cases of states by over time

In KY, heroin users are on an overall upward trend, while opioid users are on a gradual decline. The two drug cases of types finally approach gradually.

In OH, heroin and opioid users increase gradually, while heroin users decrease slightly after flattening in the later period.

In PA, the total number of heroin and opioid cases is relatively stable. When opioid cases increase, heroin cases decrease. When opioid cases decrease, heroin cases increase.

In VA, the total number of heroin and opioid cases has basically the same trend. They both have certain fluctuations and the change of cases is on the rise.

In WV, the number of cases of opioid drugs always show a decreasing trend.. The number of heroin cases show

an increasing trend in the early stage and starts to decrease when it reaches a certain period.
Five states contain more than 400 counties in the United States. This paper takes Philadelphia of PA and Hamilton of OH as examples to analyze. We obtain the graph of the number of cases of opium and heroin in recent years:

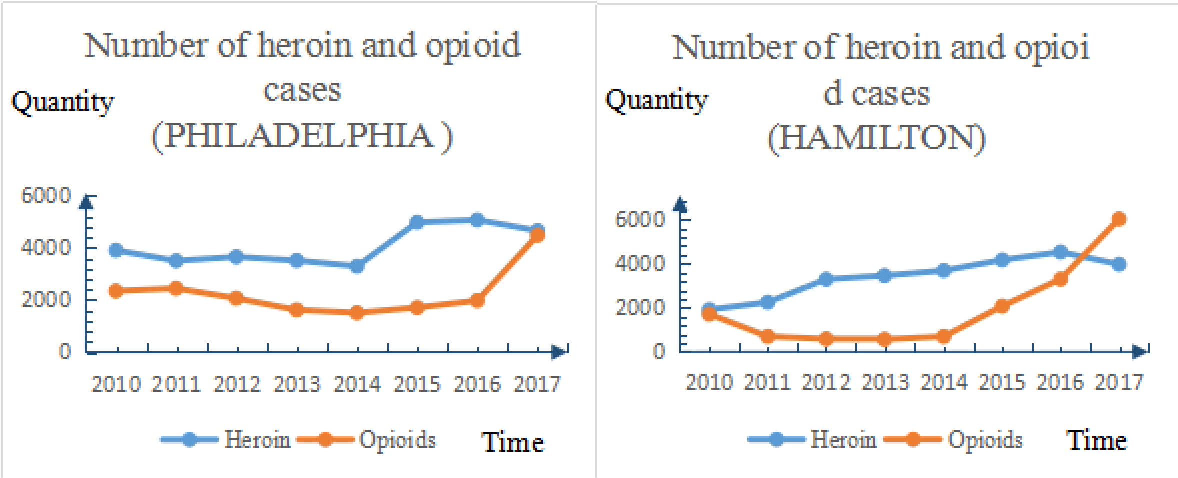

Figure 3: Trend chart of drug cases of counies by over time

The number of cases of heroin and opioid drugs is relatively stable in the early stage. But it shows an obvious upward trend after reaching a certain period.
The number of cases of heroin and opioid drugs is on the rise on the whole. But the number of cases of opioid drugs is basically stable in the middle of a period time.
By sorting out the data, we divide the data into five states and summarize the data on the map. We can obtain columnar heat maps of heroin and opioid cases in five continents.

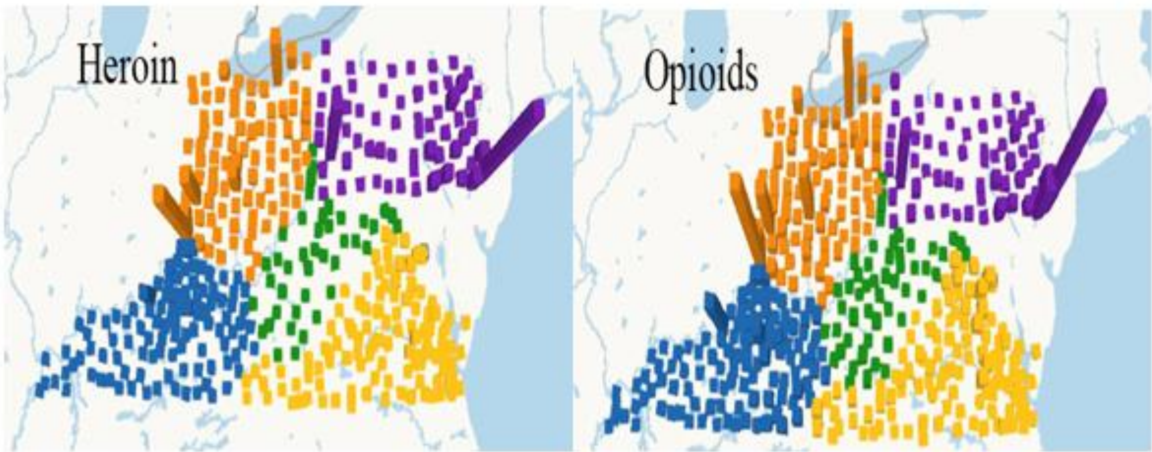

Figure 4: The number of drug cases column heat map

The height of the column represents the number of cases. The higher the column, the more cases. Drug users are obviously distributed in the border areas of various states and have certain spreading effect on the surrounding counties. However, the number of cases in the central regions of among states are relatively small, far lower than that in the border regions.

4.3.2 Establishment of model

For all Americans, we can divide them into three categories: those who do not take opium/heroin, those who take opium/heroin and spread it, those who take opium/heroin but do not spread it.
Considering factors such as the rate of drug users, the cure rate, the spread rate and so on. We establish the following differential equation:

$$N\frac{di}{dt} = \lambda Nsi - \mu Ni.$$

According to the above hypothesis, we call the annual cure rate μ as the proportion of the number of people who break away from drugs after taking drugs every year. However, the drug users who break away from drugs may still become healthy people after being cured. 1/μ is the average spread period of this drug. σ in the spread model can be defined as the average number of effective spread per user during the whole spread period, that is, the spread number. （σ=λ/μ）.

After deduction, we can get the propagation model：

$$\frac{di}{dt} = -\lambda i[i - (1 - \frac{1}{\sigma})].$$

4.4 Identification of opioid spread source

Due to the large number of opioid drugs, we chose Fentanyl, which has the largest total number of cases, as the research object.
We use the following steps to select the spread source of Fentanyl:

- The data of among counties are sorted according to time. The counties that may be spread sources are screened out by using the spread model. After selecting, the counties that have been screened out once are screened out over more by using the spread model. After repeated many times, the final spread point can be obtained.
- We divide counties which may be spread sources into districts according to states, and compare similar spread sources in the same state to find out relatively accurate counties.
- We verify and calculate the relevant data of the state that did not find the spread source, and determine whether there was no spread source in that state again. Substituting the possible propagation sources into the spread model to see if the results are close to the final data. Through these operations, it is determined whether there is really no spread source.
- Substituting the data into the available spread sources are PHILADELPHIA of PA, HAMILTON of OH, CUYAHOGA of OH.

The possible locations of fentanyl spread sources are indicated by asterisks. They are shown in the Figure 5

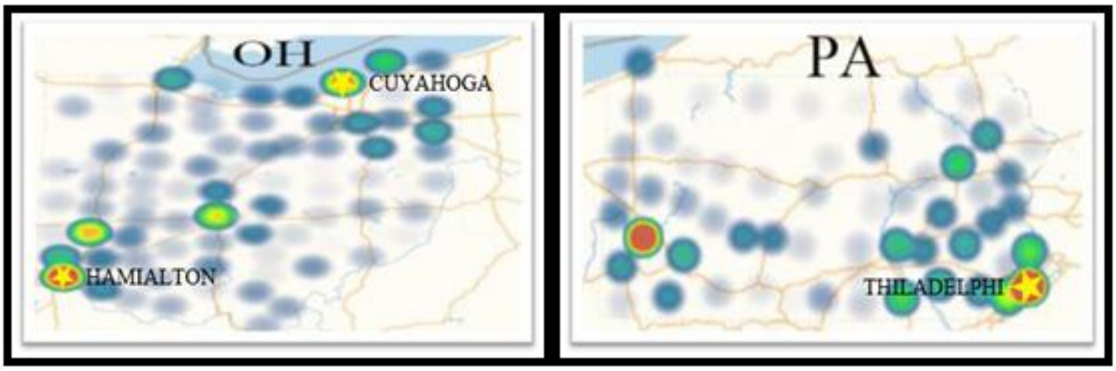

Figure 5: Distribution map of spread sources

4.5 Worry of US government

When we determine the specific opioid drugs, the drugs used for treatment will be more converted into drugs containing specific opioids. Heroin users will be greatly reduced, and the number of cases of opioid drugs will definitely increase. As a result, the control over heroin will be strengthened definitely. Some users will not be able to purchase heroin products. They will purchase large quantities of opioid drugs to replace heroin in order to satisfy their desire for drug use.

After the state / county determines the specific opioid type, the government needs to worry if the total value of opioid and heroin cases increases is more than the normal level in the process of decreasing the number of heroin cases and increasing the number of opioid drug cases. Drug users may be buying large quantities of specific opioids to replace heroin. Government departments need to strictly control these drugs to prevent their abuse from bringing harm to the country.

4.6 Judgment of threshold

4.6.1 The meaning of threshold

According to model characteristics，we can know that the threshold value of spread number is 1. When σ > 1, the drug will diffuse. When σ < 1, the drug will not spread.

4.6.2 Prediction of time and place

Grey prediction method is a mean to predict the system with uncertain factors. The grey GM (1,1) model has been widely used，due to its advantages of less required data and less calculation. A system with some known information and some unknown information is called a gray system. The gray system theory regards all random processes as time-related gray processes that changing within a certain range. Then, the research is carried out. The model of grey process is called grey model [3].

- According to the case of 2000-2017 data，supposing time series $X^{(0)}$ has n individual observations $X^{(0)}=\left\{X^{(0)}(1), X^{(0)}(2), \ldots, X^{(0)}(n)\right\}$.
- New sequences are generated by first order accumulation $X^{(1)}=\left\{X^{(1)}(1), X^{(1)}(2), \ldots, X^{(1)}(n)\right\}$.
- Generating new data $X^{(1)}=\left\{X^{(1)}(1), X^{(1)}(2), \ldots, X^{(1)}(n)\right\}$ through first-order accumulation.
- With the newly generated sequence $X^{(1)}$ to fit the curve.
- The predicted value sequence of the new sequence $X_{(1)}$ is obtained by using the fitted function $X^{(1)}$.
- Making use of $X^{(0)}(\mathrm{k})=\mathrm{X}_{(1)}K-\mathrm{X}_{(1)}(K-1)$ to inverse accumulated generating operation. It can gain gray predicted value sequence:

$$X^{(0)}=\left\{X^{(0)}(1), X^{(0)}(2), \ldots, X^{(0)}(n+m)\right\}$$ （n+m individual, m individual future predictions）.

The sequence $X^{(0)}$ was divided into Y_0 and Z_0, where Y_0 reacts deterministic growth trend of $X^{(0)}$ and Z_0 reacts the smooth periodic trend of $X^{(0)}$. The gray GM (1,1) model was used to predict the growth trend of the sequence $X^{(0)}$.

According to the characteristics of the model and the relevant data provided in this topic, we use the grey prediction model to analyze the relevant data. From the above propagation model, we know the correlation threshold is 1. That is, the balance is reached when the ratio of the proportion of newly added cases to the proportion of completed cases is 1. We will take two counties as examples for analysis.

In PHILADELPHIIA, the number of heroin cases from 2010 to 2017 were 3910, 3508, 3659, 3519, 3297, 4985, 5075, 4664. The number of heroin cases in the next five years can be predicted by substituting the eight-year case data into the grey prediction model. The predicted value are 5339, 5715, 6182, 6559, 6821. The number of opioid cases from 2010 to 2017 were 2349, 2450, 2071, 1624, 1512, 1715, 1980, 4492. The number of opioid drugs in the next five years is: 3564, 4004, 4548, 4991, 5296. It can be seen that the number of cases of the two types of drugs are increasing year by year. When the spread number is 1, the proportion of new cases is equal to the proportion of treatment completed. In other words, the number of new cases is equal to the number of cured cases, and the case data remains unchanged. Relevant data shows that the number of cases has increased year by year, so the number of cases spread in this county is bigger than 1. The county is in a state of proliferation and needs government control.

In HAMILTON, the number of heroin cases and opioid cases from 2010 to 2017 were 1917, 2248, 3291, 3458, 3686, 4167, 4525, 3970 and 1711, 701, 589, 571, 698, 2076, 3300, 6028 respectively. We substitute the relevant data into the grey prediction model to predict, and we can get the number of heroin and opioid cases in the next five years are 4874, 5264, 5752, 6145, 6417 and 3629, 3133, 2289, 2144, 2134. The ratio of the proportion of newly added cases to the proportion of completed cases is compared with the threshold value by using the data. We can find that heroin has a tendency to spread. The government needs to strengthen control, while opium is in a convergence trend and developing normally.

V. Optimization Of Spread Model

5.1 Data processing

1. Delete outliers: A number of indicators are given in the data table, some of which have null data and we will delete them.
2. Delete useless values: Such as errors, percentages and error percentages given in the table are useless data.
3. Select potential people taking drugs as indicators: For the remaining 40 indicators, we selected five categories

as research objects after analyzing them: unmarried women, single parent families, education level, Left - behind Children and High School Students.

5.2 Selection of indicators

The above propagation model is an ideal model without considering the influence of other factors on the propagation process. This paper selects five factors to optimize the propagation model. The section will focus on these five aspects.

- **FERTILITY - UNMARRIED WOMEN (Widened, Diverted, and Never Married) - PER 1,000 UNMARRIED WOMEN:** These women have lost their emotional support. They are too bored to stay at home for a long time. They often go in and go out of bars and other places, easily infected with these drugs.
- **Family type-female household holder, no husband present, with own children under 18 years:** For this kind of family, the father or mother usually neglects to discipline the children and will dote on the children and obey their ideas. When they come into contact with opioid drugs, they can not know the harmfulness of drugs and they are prone to addiction.
- **Education level - less than 9thgrade:** Most of the social workers with low educational background belong to the bottom of the society and have low educational level. They do not have a clear understanding of the harm of opioid drugs. The younger children, who are easily influenced by others, will become interested in them when they see someone smoking opioid. These people have a high probability of taking opioid, due of poor resistance and easy addiction [4].
- **The Time of Grandparents Take Care of Their Grandchildren:** Children cared for by grandparents are called left-behind children. They do not have a correct view of right and wrong, good and evil. Their rebellious heart is very high. These children are easily exposed to eat opioid drugs and have poor resistance.
- **High school students:** Teenagers belong to rebellious teenagers in this period. The state does not have a high level of supervision over opioid drugs and they are easy to obtain drugs. Teenagers think that opioids can bring happiness to themselves and they are easy to become addicted.
-

5.3 Correlation analysis

In this paper, the filtered relevant data are integrated and classified into lists by year, index and county.

Table 2: The number of cases and socio-economic characteristic data

Country name	Number of cases in 2010	Number of cases in 2011	Unmarried women	Single parent families	Education level	Left-behind children	High school students
ACCOMACK	9	38	47	966	1919	104	1829
CUMBERLAND	7	8	0	176	762	3	406
FLUVANNA	6	27	49	452	1081	60	1304
HIGHLAND	195	161	0	34	130	12	107
MIDDLESEX	4	2	0	153	376	49	589

Here, we select the data of five counties of ACCOMACK, CUMBERLAND, FLUVANNA, HIGHLAND and MIDDLESEX for analysis. After correlation analysis of these data, the following table is obtained:

Table 3: Correlation analysis table

Relevance								
		@2010	@2011	ACCOMACK	CUMBERLAND	FLUVANNA	HIGHLAND	MIDDLESEX
@2010	Pearson correlation	1	.979**	.398	.667	.564	.455	.876
	Significance		.004	.508	.428	.322	.441	.309
@2011	Pearson correlation	.979**	1	.607	.487	.793	.496	.735
	Significance	.004		.738	.640	.513	.628	.504
ACCOMACK	Pearson correlation	.398	.607	1	.848	.834	.809	.926*
	Significance	.508	.738		.069	.079	.097	.024
CUMBERLAND	Pearson correlation	.667	.487	.848	1	.976**	.904*	.963**
	Significance	.428	.640	.069		.004	.035	.009
FLUVANNA	Pearson correlation	.564	.793	.834	.976**	1	.814	.941*

	Significance	.322	.513	.079	.004		.094	.017
HIGHLAND	Pearson correlation	.455	.496	.809	.904*	.814	1	.935*
	Significance	.441	.628	.097	.035	.094		.020
MIDDLESEX	Pearson correlation	.876	.735	.926*	.963**	.941*	.935*	1
	Significance	.309	.504	.024	.009	.017	.020	

By observing Pearson correlation coefficient in the above table, we can obtain that the number of drug cases has a strong correlation with the socioeconomic indicators through screening. There is obvious positive correlation between them.

5.4 The new model

We classify the data according to socioeconomic indicators. Then the classified data and the number of cases is analyzed. We can get that the data corresponding to each index has its critical value. When the critical value is exceeded, the index is beneficial to the diffusion of medicine. If it is less than the critical value, this feature is conducive to reducing the number of drug users.

In this paper, the index number is written for each index in sequence. The number of families corresponding to the index is set as h_i, and there is a critical value of the number of families corresponding to the index. We take the ratio of the index number of households in this county minus the critical value to the total number of households in this state as a coefficient a_e [5].

At this time, the relationship between the propagation rate λ' and the original propagation rate λ can be expressed by equation (1):

$$l' = l + a_1h_1 + a_2h_2 + a_3h_3 + a_4h_4 + a_5h_5. \quad (1)$$

The improved model can be obtained by bringing the new propagation rate into the original model:

$$\frac{di}{dt} = -\lambda'\left[i - (1 - \frac{1}{\sigma})\right].$$

After the model was improved, indicators of social and economic types were added. It can be seen from Task 1 that the number of cases fluctuates greatly over the years. According to the social and economic data given in the topic, we can get that socioeconomic factors have a guiding effect on the fluctuation of cases. We use the critical value of a single socio-economic characteristic to calculate its influence on the spread rate and superimpose the influence on the spread rate. Finally, the result of ideal spread rate under the influence of social and economic factors is obtained, which makes it closer to the actual data to a higher degree.

We take Heroin's cases in CUMBERLAND as an example. By comparing the original data, model 1 prediction data and model 2 data, we get the following **Figure 6**:

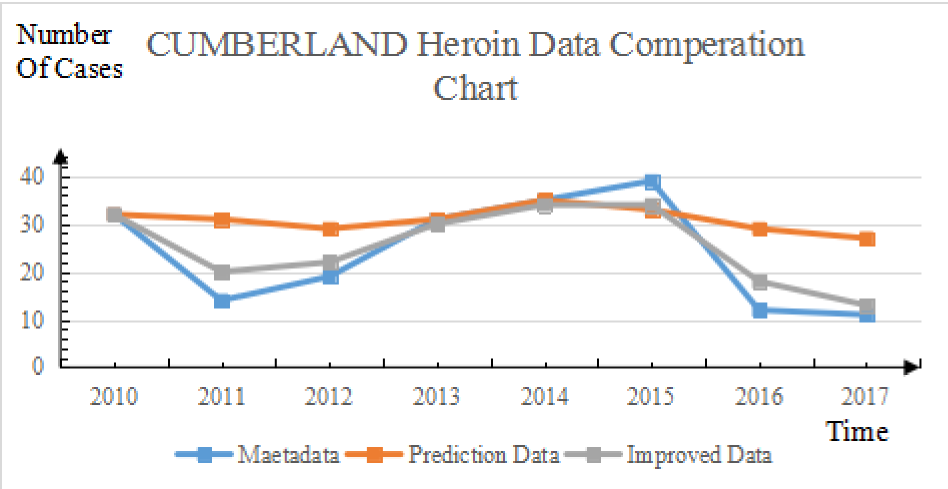

Figure 6: Comparative analysis chart

Analysis of the trend in the graph shows that the data in model 2 are more appropriate to the original data. In this way, the agreement between the model and the data has also been improved.

6 The response to the drug crisis

Before solving this problem in depth, briefly explain the whole idea, analysis the flow chart shown in **Figure 7**:

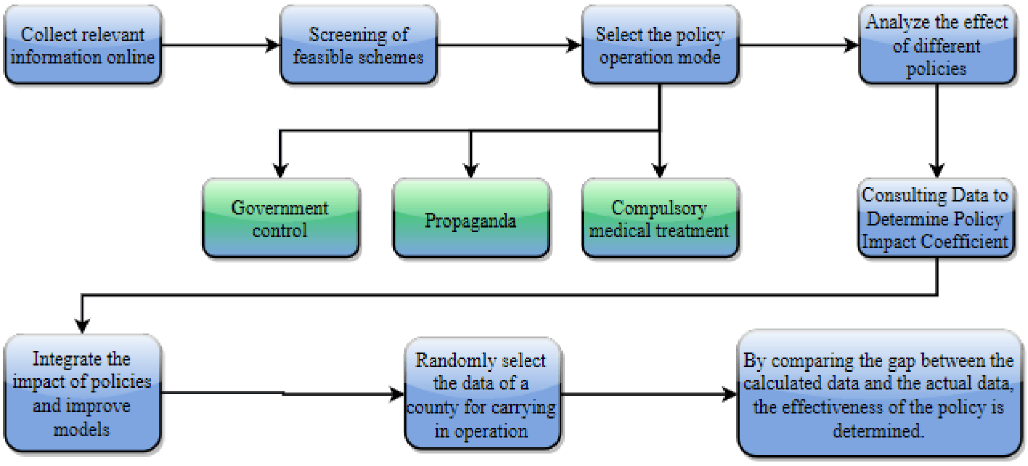

Figure 7: Task 3 flow chart

6.1 The strategy of drug crisis

According to the above model substituted into the data calculation, it can be obtained that opioid drugs are spreading in many counties. In order to solve the crisis of opioid drugs, we have formulated strategies to deal with this crisis:

- **Government control:** The government strictly controls the trafficking of opioid to prevent the random outflow of drugs from the source. Through this move, the punishment will be increased and the potential crowd will be reduced [6].
- **Publicity role:** In order to make people realize the harmfulness of opioid drugs, we conduct harmfulness publicity in various public gathering points (squares, schools, communities) to make people realize the harmfulness of drugs and reduce potential crowd [7].
- **Government Compulsory Treatment:** The government conducts compulsory detoxification for people addicted to opiates. They can be sent to drug rehabilitation centers and communities for drug treatment, thus reducing drug users.

6.2 Testing of validity

6.2.1 Quantification of policy

These coping strategies optimize our model by changing σ value. They control opioid users by influencing the spread rate and cure rate.

In this section, we mainly quantify these factors:

- **Government control:** We bring the number of cases in a single county over the years into the grey prediction model to predict the number of cases(b) in the following year. Set the state's control level as c. If b=c, drugs will be completely banned, resulting in real patients having no drugs to buy, so c must be less than b. The amount of drugs sold can be expressed as: b-c. Since the sale of drugs directly affects the spread, we can convert the government control value into the limit factor d of the spread rate.
- **Propaganda:** Propaganda has a certain deterrent effect on the spread rate. The input of publicity will make people realize the destructively harm of opioid drugs. Let's say that the propaganda input is q times the original. Since repeated publicity will weaken the effect, we set the publicity effect to be 1.3^q times the original. Publicity is not crucial to the impact of the spread rate. We assume that the affected spread rate will become $\lambda' - 0.1 \times 1.3^q \lambda'$.

Because the number of drug addicts accounts for a small number of cases, and drug addicts are more difficult to voluntarily give up drugs because of publicity. We set the propaganda investment to be q times the original. According to the proportion of drug users involved, we can initially draw up the cure rate to be converted to $\mu(1+1\%)^q$.

- **Compulsory government treatment:** The government can effectively find drug addicts and treat them by increasing the census of drug addicts and the number of investigations. We can set the population census scope for drug abuse to be k times and the number of times to be w times. Then the current cure rate should be k times that of the original (kμ) under the condition of expanding the scope. When increasing the number of population censuses, the cure rate can be changed to $k m(1.1)^{w}$.

PS: According to the relevant data and the analysis of the current situation in the United States, some of the above values are given.

Through the influence of these factors, the number of spread from the original $s = \frac{l\,'}{m}$ to $s\,' = \frac{(l\,'- 0.1\acute{}\ 1.3^{q} l\,')\,d}{k[m(1+1\%)^{q}]1.1^{w}}$.

Adding coping strategies is equivalent to adding constraints to the model. At this point, our model becomes:

$$\frac{di}{dt} = -[(\lambda' - 0.1\times 1.3^{q}\lambda')\,d]\left[i - (1 - \frac{1}{\sigma'})\right].$$

6.2.2 Efficiency analysis

- Government control can affect the restriction coefficient. When c increases, b-c decreases and d also decreases. It reduces the number of spread and controls the speed of drug spread.
- Influenced by publicity, the spread rate is converted to $l\,'- 0.1\acute{}\ 1.3^{q} l\,'$ and the cure rate is converted to $m(1+1\%)^{q}$ .When q increases, 1.3^{q} increases, $-0.1\acute{}\ 1.3^{q} l\,'$ decreases, and the propagation rate decreases. At the same time, $(1+1\%)^{q}$ increases, the cure rate has also increased. This policy is very sexual.
- In the process of compulsory treatment by the government, the cure rate can be converted into $k m(1.1)^{w}$.

When k increases, $k m$ increases. When w increases, the $(1.1)^{w}$ also increases, the greater the cure rate is, thus fewer people take the drug.
Reasonable use of the above three strategies can effectively control the spread rate of drugs. So these strategies are very effective.

6.2.3 Validation of model

Considering the reality of the United States, we selected HENDERSON's relevant data for analysis. We take the government control policy as an example to explore. As can be seen from the above, before the control was carried out, $s = \frac{l'}{m}$ .According to the analysis of online data, the limit coefficient d of government control can reach 0.7 for a single county. For the sake of economic benefits, the publicity investment is generally twice as much as the original, that is q=2. When analyzing a single county, the value of k is almost equal to 1. However, according to the U.S. population and its census, the number of surveys w can be increased to 2.

HENDERSON's cases of opioid drugs from 2013 to 2016 were 11, 11, 12 and 24. If the county is set before the control $s_{1} = \frac{l_{1}'}{m_{1}}$, the current situation $s_{2} = \frac{0.8517 l_{1}'}{1.234321 m_{1}}$ can be obtained after the control. Since l_{1}' and m_{1} are greater than 0, they must be less than s_{2}. That is the county's diffusion rate dropped after the policy is implemented. In the actual real data, the county's diffusion rate is on the rise, so the government's control policy is effective.

6.3 The parameter limit

1.The government plays a crucial role in drug control. However, people who are really sick and need drug treatment also account for the majority of the total cases. Considering the comprehensive data, when c=0.3b, the government control can reduce the spread rate and provide enough therapeutic drugs for patients.
2.According to the ratio of propaganda input, we analyze the spread rate and cure rate. When q is 4, propaganda can effectively reduce the spread rate and be more suitable for economic requirements. There is also some improvement in the cure rate.

Table 4: Limit factor analysis selection table

Multiple of Investigation	1	2	3	4	5
Effect multiple	1.3	1.69	2.197	2.8561	3.71293
Effect growth rate	0.3	0.3	0.3	0.3	0.3
Overall growth Rate	0.3	0.009	0.027	0.0081	0.00243

3.From the government's compulsory treatment formula for drug users. We can know that the effect is best when the census scope reaches the maximum. As the base number is 1.1, we can obtain
Table 5::

Table 5: Limit factor analysis selection table

Multiple of Investigation	1	2	3	4	5	6
Effect multiple	1.1	1.21	1.331	1.4641	1.61051	1.771561
Effect growth rate	0.1	0.1	0.1	0.1	0.1	0.1
Overall growth Rate	0.1	0.01	0.001	0.0001	0.00001	0.0000001

The observation data table shows that when the number of times increases to more than three times, the overall growth rate is slow. The small amount of data, but the cost of personnel and financial resources consumed is relatively high. Therefore, when w=3, the effect is the best.

VI. Conclusions

In this paper, we have established an idealized differential equation propagation model. Through this model, we can get the spread Characteristics of opioid drugs in States/Counties.

On this basis, we screen indicators for correlation analysis. We can find that these socio-economic factors have strong positive correlation. Some social and economic indicators have been added to make our spread model closer to reality.

In order to alleviate the opioid crisis in the United States, some factors that control the spread rate of drugs are considered. They are used as constraints to optimize the model again. By comparing the models before and after optimization, we find that the model is very effective.

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Lili Wang. "Modeling and Analysis of Drug Spread System." *IOSR Journal of Mathematics (IOSR-JM)*, 16(6), (2020): pp. 16-27.