OPIOID USE DISORDER & OPIOID MISUSE IN SNOHOMISH COUNTY:

Using Capture-Recapture to Estimate the Burden of Disease

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Introduction

Prior to June 2017, the only primary data available to monitor the worsening opioid crisis in Snohomish County was the number of opioid-related overdose deaths. Even then, it could take 12-18 months to get preliminary numbers.

To address this issue, in July 2017, the Snohomish Health District embarked on several innovative opioid data-collection methods. One was a point-in-time survey done in collaboration with local partners to collect real-time data on overdoses for one week. The results in 2017: 37 total overdoses in Snohomish County during that week, including three deaths. The Snohomish Health District took the opportunity to repeat the seven-day point-in-time collection again in 2018. The results in 2018: 57 overdoses, two of which were fatal. This trend confirmed suspicions that the opioid crisis was worsening.

Through the Opioid Response Multi-Agency Coordination (MAC) Group efforts, additional data sources have been accessed through partnerships with hospitals, law enforcement, fire, EMS, the syringe exchange, and other partners. With funding from Snohomish County's 1/10 of 1% Chemical Dependency and Mental Health Sales Tax, and access to these new data sources, the Snohomish Health District employed another novel method, known as capture-recapture, to estimate the true burden of disease for opioid use disorder and opioid misuse in Snohomish County. There were four primary objectives for this project:

- Understand the difficulty of opioid surveillance
- Explain methods to mitigate the problem
- Review use of surveillance for disease burden
- Report capture-recapture and disease burden results.

Through this process, an estimated range was identified for those individuals in Snohomish County who are either misusing opioids or have an opioid use disorder. These are considered the two ends of the spectrum for diagnosable patterns that can lead to overdose and death. This data will aid the Snohomish Health District and the MAC Group with evidence-based decision-making, assessment of interventions, and other planning purposes.

Background

Prior to embarking on the project, it was important to look at existing data sets and determine a common set of definitions.

Opioid Misuse vs. Opioid Use Disorder Criteria

With the new release of the Diagnostic and Statistical Manual of Mental Disorders, 5th ed. (DSM-5), there are some changes to terminology. The terms "substance abuse" and "substance dependence" have been abandoned and replaced with substance use disorder.

Substance use disorder can be categorized as mild, moderate, or severe. It is determined by the number of diagnostic criteria met, with at least two of the following four criteria required:

1. Impaired control:
   a. Using for longer periods of time than intended
   b. Using larger amounts than intended
   c. Wanting to reduce use but not able to do so
   d. Spending excessive time getting, using, or recovering from drugs
   e. Intense cravings.
2. Social impairment:
   a. Repeated involvement with a substance or activity, despite the substantial harm it now causes to relationships or ability to function in society (e.g., work).
3. Risky use:
   a. Repeated use in physically dangerous situations or use despite knowledge that the drug is causing or worsening physical and psychological problems.
4. Pharmacological indicators
   a. Tolerance: need to increase the amount of a substance to achieve the same desired effect
   b. Withdrawal: cluster of unpleasant and/or fatal symptoms after abrupt cessation of drug.

Using this same criteria, **opioid use disorder** (OUD) is a substance use disorder involving an opioid. **Opioid misuse,** on the other hand, is intermittent use of any of the following that does not meet the definition of opioid use disorder.

- An illicit opioid, such as heroin
- Someone else's prescription opioid
- One's own prescription opioid other than as prescribed (e.g., higher dose, more frequent, for a different reason).

Current Data Trends in Snohomish County

Snohomish County saw a peak of 145 opioid-related deaths in 2011. The numbers decreased for a couple of years before leveling off. In 2017, the number of overdose deaths associated with heroin overtook those associated with prescription opioids for the first time in the county. In addition, deaths linked to fentanyl—the synthetic opioid that is far more lethal than heroin—more than doubled in just a few years.

**Opioid-Related Deaths in
Snohomish County, 2006-2018***
*(*2018 data is preliminary through Nov. 30)*
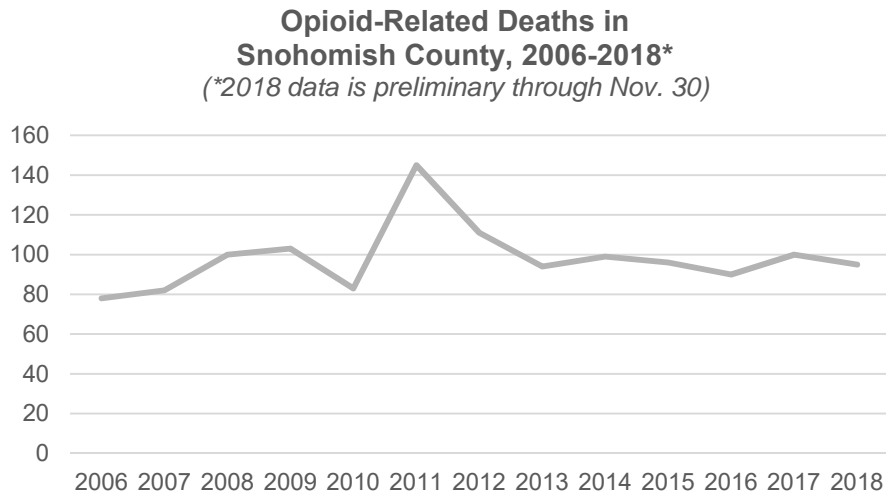
Source: Washington State Department of Health

As is being seen in other parts of the state and country, this epidemic has led to increasing secondary impacts in local communities. Persons engaging in drug use also have a higher risk of acquiring sexually transmitted infection due to reasons such exchanging sex for drugs. Therefore, the epidemic may also partially account for rising rates of syphilis, gonorrhea, chlamydia, and other similarly transmitted diseases. Snohomish County had 101.1 gonorrhea infections per 100,000 residents in 2017, which is nearly three times the 2008 rate.
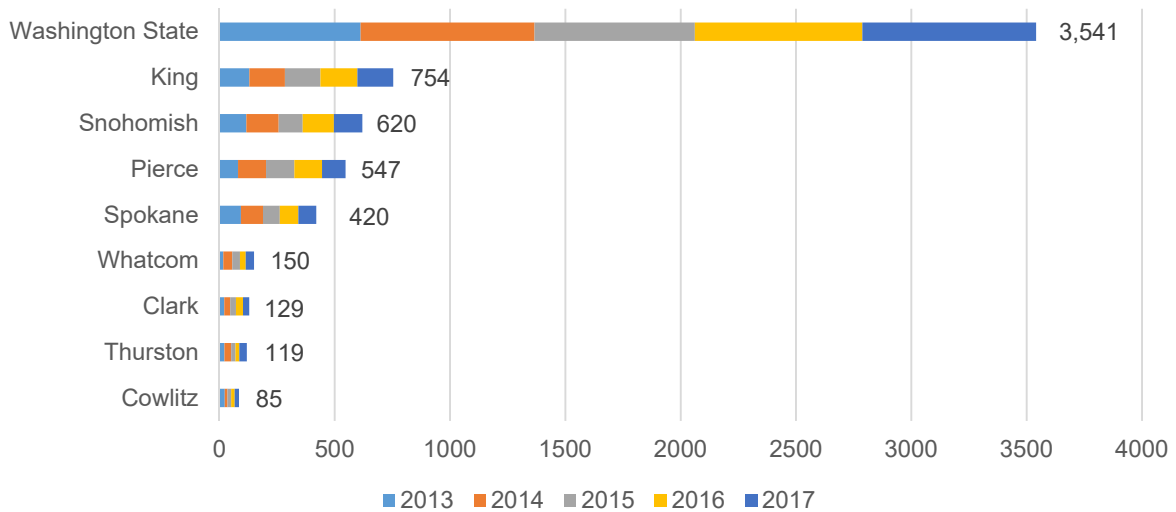
Nationally, persons born before 1965 have been replaced by persons who inject drugs as the primary demographic for newly identified hepatitis C infections. In Snohomish County, the number of hepatitis C cases in 2017 was almost 53% higher than in 2016.

**Newly Identified Chronic Hepatitis C Infections in
Snohomish County, 2013-2017**
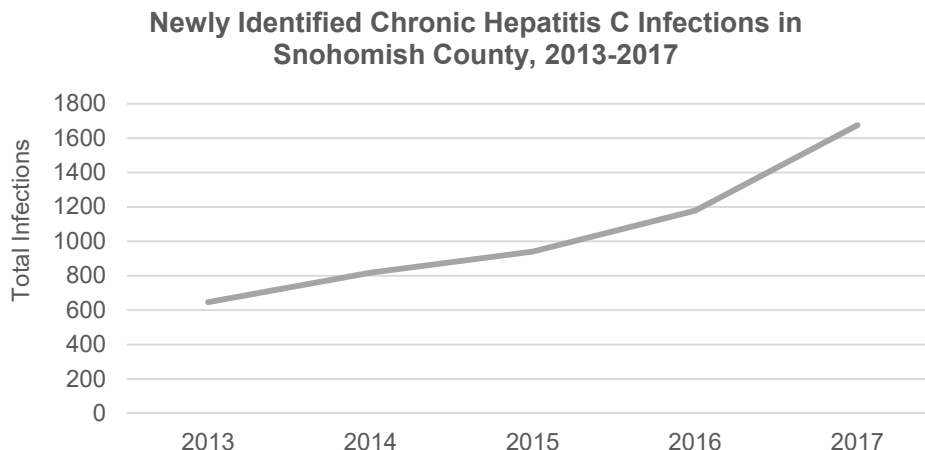
Source: Snohomish Health District Surveillance Data

Also increasing in Snohomish County is the number of babies born with neonatal abstinence syndrome (NAS) caused by an infant's exposure to opioids while in the womb. When comparing the total number of cases, Snohomish County has the second highest number in the state.
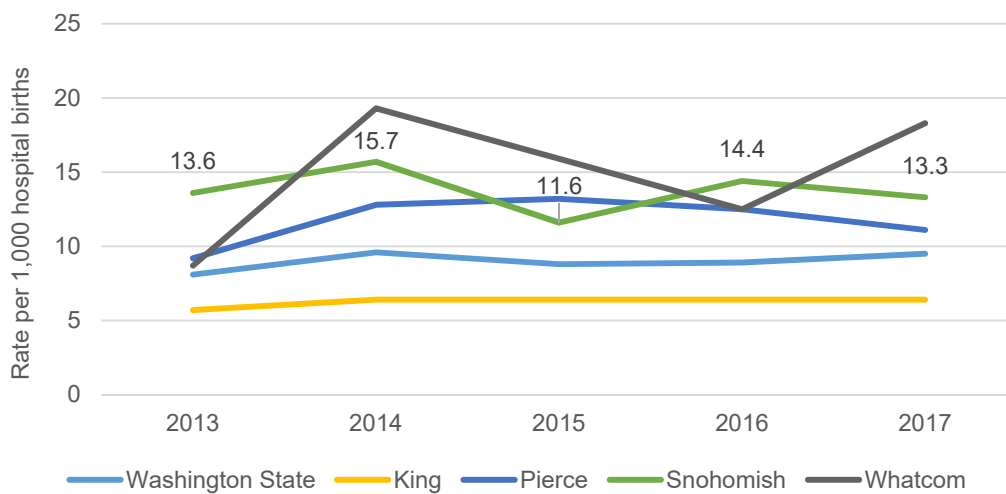
Total Number of Neonatal Abstinence Syndrome Cases, Hospital Discharge Data (2013-2017)

County	Total
Washington State	3,541
King	754
Snohomish	620
Pierce	547
Spokane	420
Whatcom	150
Clark	129
Thurston	119
Cowlitz	85

Legend: 2013, 2014, 2015, 2016, 2017

Source: Washington State Department of Health

When looking at it by rate, Snohomish County actually has a higher rate of babies born with NAS compared to King County.

**Neonatal Abstinence Syndrome Per 1,000 Births, Hospital Discharge Rates, 2013-2017**

Rate per 1,000 hospital births

Data labels: 13.6, 15.7, 11.6, 14.4, 13.3

Legend: Washington State, King, Pierce, Snohomish, Whatcom

Source: Washington State Department of Health

New Partnerships with Local Hospitals

The Snohomish Health District partnered with Providence Regional Medical Center Everett (PRMCE) thanks to a Centers for Disease Control and Prevention (CDC) grant awarded through the Washington State Department of Health. This work not only allows us to collect data on overdose and withdrawal patients in the emergency department, but additionally, hospital staff are able to perform some limited outreach to those patients.

**Opioid-Overdose Emergency Visits by Month at PRMCE ED,
June 2017 - Sept. 2018 (n=437)**
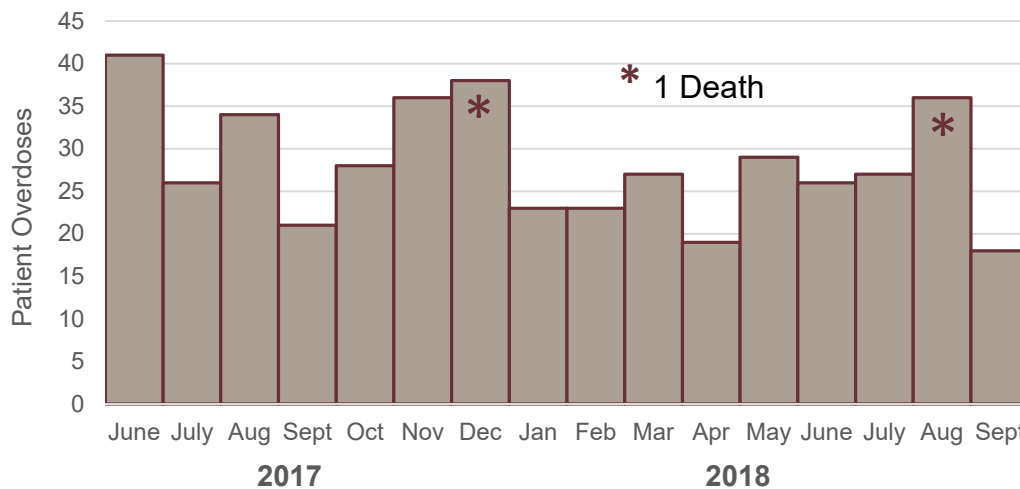
Source: Snohomish Health District and Providence Regional Medical Center Everett

The Challenges of Opioid Surveillance

While each of the data points shared earlier are important, they alone cannot provide a complete picture of the opioid epidemic in Snohomish County. This is difficult for a few key reasons:

- Substance use disorder is not a notifiable disease in Snohomish County, and there have been a variety of legal constraints that have prevented that from happening
- Deaths due to overdoses are impacted by the availability of the opioid overdose-reversal drug naloxone
- Hepatitis C infects persons other than those using and does not include prescription drug misusers
- Neonatal abstinence syndrome has small numbers and does not include males.

Given this, the Snohomish Health District has been partnering with other agencies to gain access to other record-level data. These include FirstWatch, ESSENCE, and ODMAP.
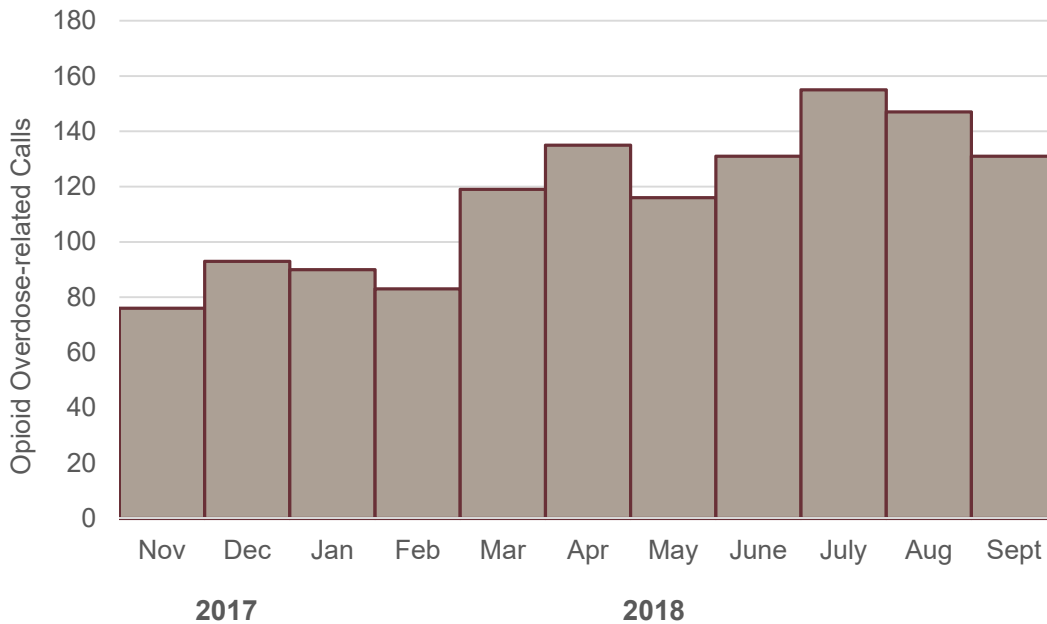
FirstWatch

With the merger of SNOCOM and SNOPAC, the county's two 911 call centers, the newly established Snohomish County 911 started consolidating dispatch data for the 47 police and fire agencies it serves in mid-2018. This also included utilizing FirstWatch, a proprietary record management system for EMS calls. FirstWatch takes the raw data from multiple programs and creates "triggers" for opioid overdose-related calls.

FirstWatch is currently set up to send alerts to registered recipients for opioid overdose calls identified through text searches. Searches can be completed on either the alerts themselves or by searching the text found within the record-level data.
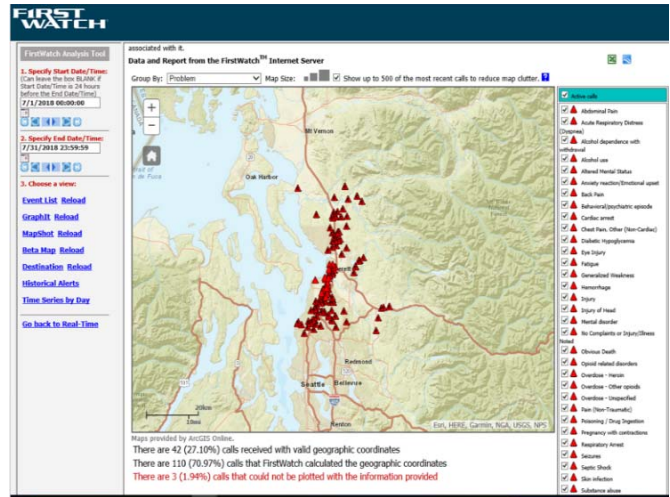
When performing a key word search for data, there were 1,390 records from November 2017 through September 2018 that were returned as possible opioid-related overdoses. It is important to note that not all calls were integrated into FirstWatch until later in 2018, which may be why the chart below shows an increase in calls in the latter half of the year. Secondly, the search results are based on an initial report and not yet verified or deduplicated.

Opioid Overdoses in FirstWatch Identified by Record Search
**Nov. 2017 - Sept. 18 (n = 1,390)**

Source: Snohomish Health District and FirstWatch

ESSENCE

The CDC's National Syndromic Surveillance Program developed its BioSense Platform originally as a way to track bioterrorism-related illness. Over the years it has expanded to help public health officials analyze and exchange data for situational awareness of health threats and response for hazardous events and disease outbreaks.

A component of BioSense is the Electronic Surveillance System for Early Notification of Community-Based Epidemics, or ESSENCE. Developed by Johns Hopkins University, ESSENCE allows us to capture data in multiple formats, then analyze, store, and share that data.
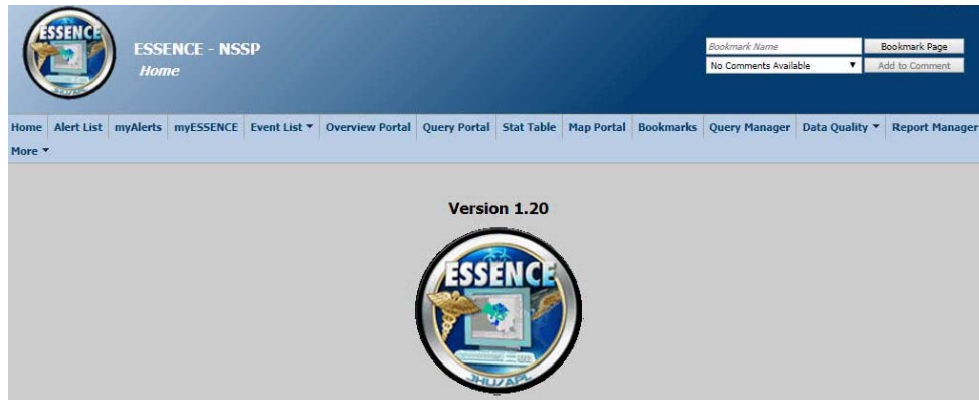

While the variables collected by the system are currently limited, the Snohomish Health District is collaborating with the Washington State Department of Health to validate ESSENCE though a CDC-funded study and establish permanent access to real-time data.

ODMAP

Another tool for first responders in the community to track overdose information is ODMAP. Developed by the Washington/ Baltimore High Intensity Drug Trafficking Areas (HIDTA), ODMAP is a free mobile app downloaded to law enforcement phones or computers to input opioid overdoses on the scene and in real time.

Washington/Baltimore HIDTA has offered the program to law enforcement and public health partners around the country. The Snohomish Health District and Snohomish County Sheriff's Office were the first in the county to sign on, and other local agencies are in the process of coming online in 2019. Another CDC grant awarded to the Washington State Department of Health will focus on getting at least 10 more counties in the state onboard. It will also provide funding for the Snohomish Health District to help integrate FirstWatch and ODMAP data into real time reporting and trigger warnings.
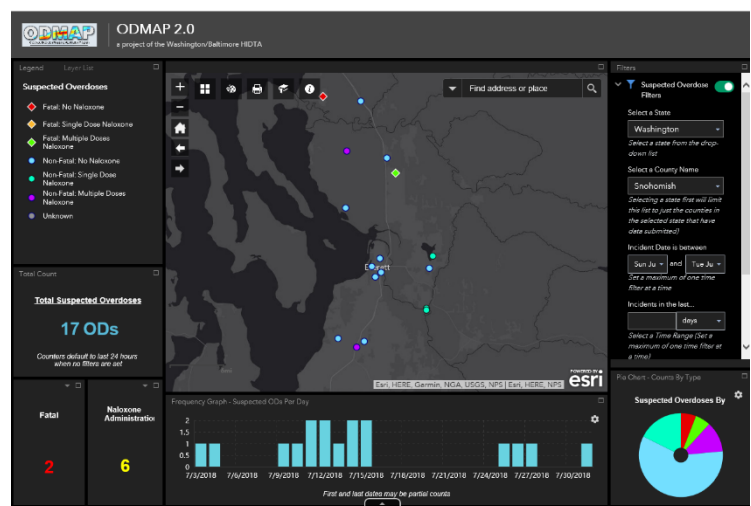
Determining the Burden of Disease for the Opioid Crisis

The data sources mentioned so far in this report are specific to surveillance or to tracking specific cases and trends. Estimating the burden of disease is a different process with a different purpose. Here the goal is to identify approximately how many individuals in a geographic area have a specific disease. The differences between surveillance and disease burdens are highlighted below:

Surveillance	Disease Burdens
Monitors specific symptoms, events, or diagnoses	Seek to identify all cases in a given geographic area or population
Allows for early identification of changes in trends (e.g., "outbreaks," positive results of interventions)	Used for planning and budgeting
Relies on historical trends to identify new changes	Critical for needs assessment and access when disease incidence is increasing
Does not need to identify all cases to be effective	Special studies can allow surveillance system to define disease burden

Disease burden estimates are challenging to complete in populations that are difficult to identify or pinpoint. It becomes increasingly more complex when the disease is not a notifiable condition, like measles or whooping cough. While the published literature is sparse, it is possible to establish surveillance for opioid events in order to estimate the disease burden. This requires an additional method known as capture-recapture.
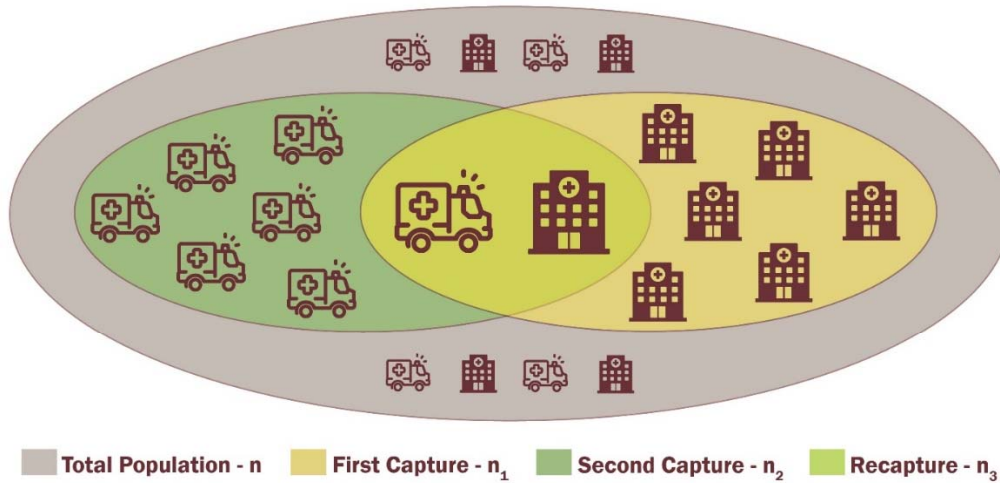
The Capture-Recapture Method

Capture-recapture was originally developed to estimate population size in wildlife studies.[2,3] This method requires two overlapping datasets that are presumably incomplete but intersecting.[4] There are some limitations to capture-recapture, but it is particularly effective for estimations of elusive populations such as people with opioid use disorder.

It has also been adapted in multiple studies of human conditions in recent years. For instance, it was used in 2015 to study chronic kidney disease in Manitoba, Canada.[5] The three methods used to determine the burden of disease included:

- Taking all cases captured by the billing data and laboratory data, adding those together, and then dividing that total by Manitoba's population. Note that this figure was likely an underestimate of the true prevalence because it would not have included people in the early stages of disease who had not yet been diagnosed.
- Taking all cases captured through laboratory data and dividing it by the number of patients where laboratory work was required to make a diagnosis (positive or negative).
- Using both the administrative and laboratory data to estimate disease prevalence through a capture-recapture method using the Chapman formula.[3]

A graphic describing the capture-recapture sampling process is shown on the following page.

Capture-Recapture
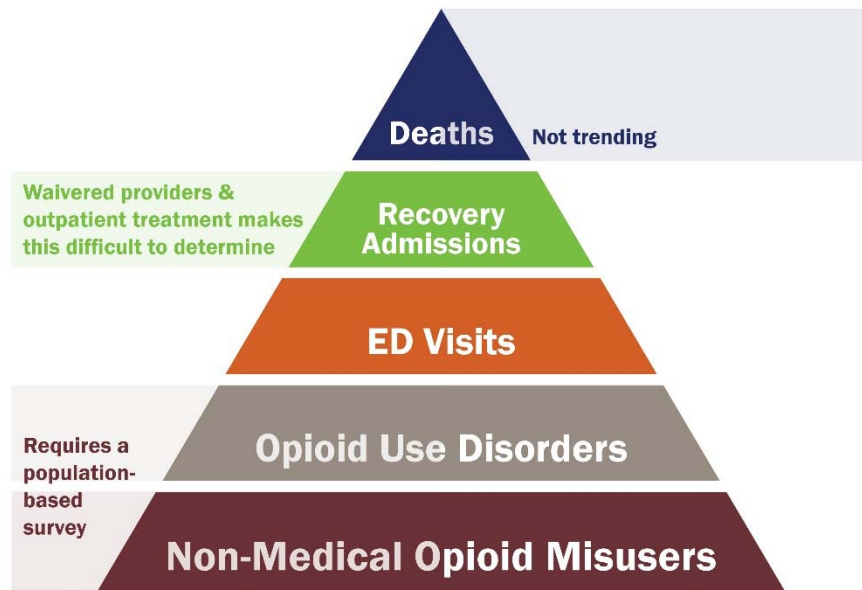

| Total Population - n | First Capture - n_1 | Second Capture - n_2 | Recapture - n_3 |

Where:
n = Size of population
n_1 = Number tagged
n_2 = Number sampled
n_3 = Number tagged in the sample

$$n = \frac{n_1 \times n_2}{n_3}$$

Applying Capture-Recapture to Opioid Use

This method had not yet been used publicly to determine the number of individuals with opioid misuse or opioid use disorder prior to starting this project earlier this summer. In November 2018, a study was published in the American Journal of Public Health where researchers performed a capture-recapture analysis to estimate the number of people in Massachusetts with OUD.[6] They determined that the prevalence of opioid use disorder for those 11 years or older was 4.6%.

For the purposes of this study, the following data points in Snohomish County were considered:


Deaths — Not trending

Waivered providers & outpatient treatment makes this difficult to determine — **Recovery Admissions**

ED Visits

Requires a population-based survey — **Opioid Use Disorders**

Non-Medical Opioid Misusers

There were essentially three steps to this process: obtain FirstWatch data as the first "capture," collect emergency department data from PRMCE for the "recapture," and then look for patients in both databases to calculate the best estimate of overdoses in the county. For the analysis, July 2018 was identified as the time period to use for the data extraction and comparison.

Step 1: FirstWatch "Capture"

As mentioned earlier, searches can be done on alerts or record-level data within FirstWatch. For the month of July, there was a total of 535 calls in the system identified through an alert search.

The sentinel alerts were evaluated to eliminate any duplications, such as a call that may have had both law enforcement and EMS responding to the same incident. Most of the other calls were clearly not overdoses, which implies that the search can be refined. Two calls were a duplicate for the same patient due to different responding units. Two other calls that looked to be duplicates for the same location were actually responses for two different patients.

As shown below, the record searches in FirstWatch had fewer duplicates than an alert search. Those records were then individually analyzed and medically verified to ensure patient notes were consistent with an opioid overdose event. Only 53% of the records identified as possible overdoses through text search were actually overdoses.
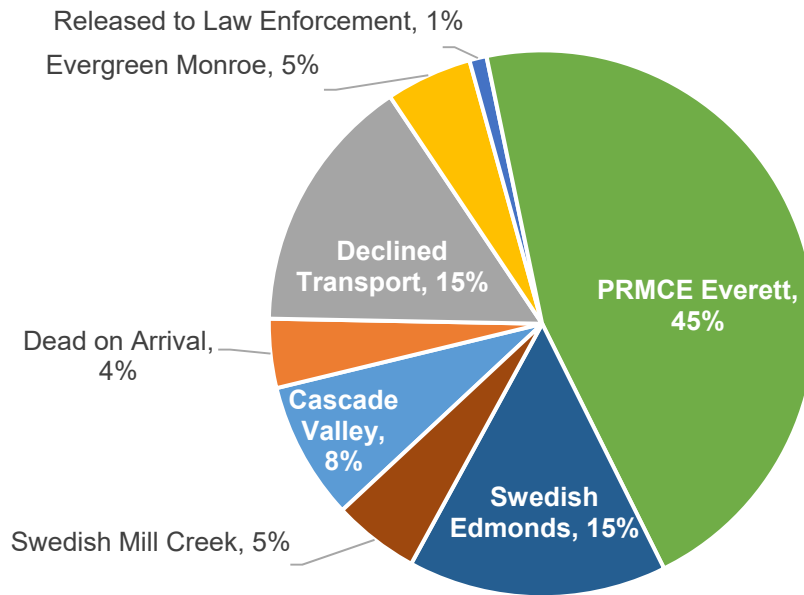
Comparison of Search Criteria for Opioid Calls in FirstWatch
July 2018 (n=535)
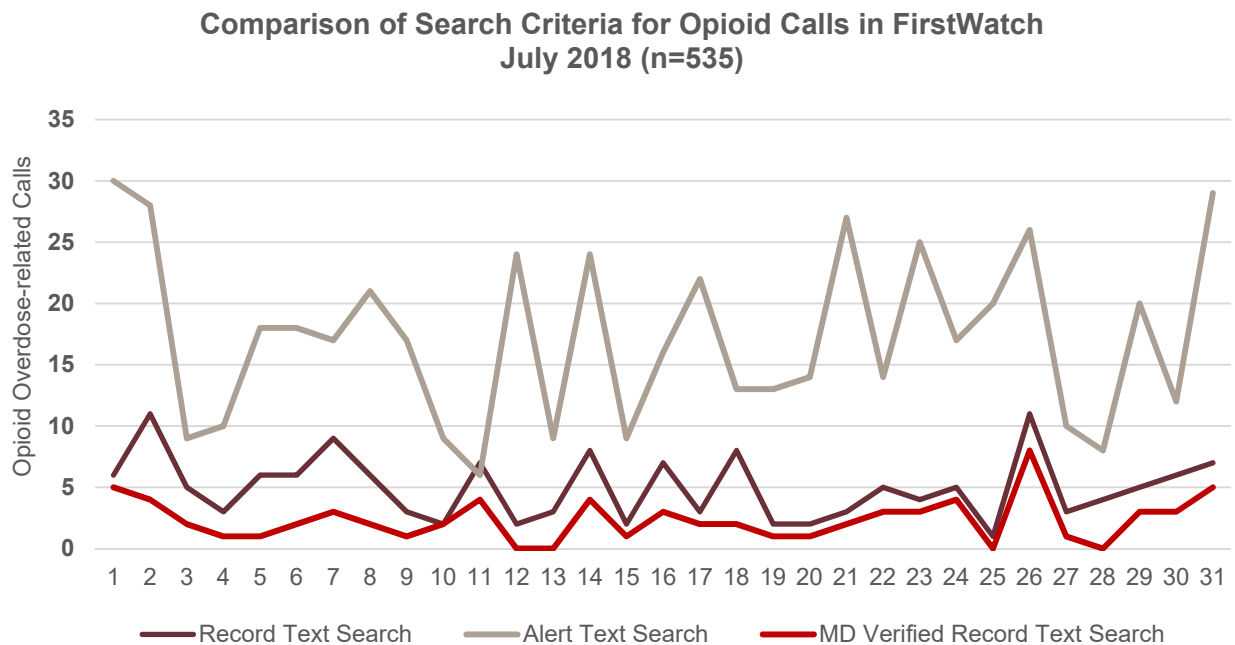
Source: Snohomish Health District and FirstWatch

Step 2: PRMCE Everett "Recapture"

With the verified data from FirstWatch, the location of patient transports for opioid-related overdoses were identified, if applicable. The chart below shows the breakdown by destination:

MD Verified *FirstWatch* Opioid Overdoses, By Destination
July 2018, n=73

- Released to Law Enforcement, 1%
- Evergreen Monroe, 5%
- Declined Transport, 15%
- Dead on Arrival, 4%
- Cascade Valley, 8%
- Swedish Mill Creek, 5%
- Swedish Edmonds, 15%
- PRMCE Everett, 45%

Source: Snohomish Health District and FirstWatch

There were 45% of the patients in FirstWatch that were transported to PRMCE Everett's emergency department, or a total of 29 opioid-related overdoses.

Step 3: Compare Patients in Both Capture and Recapture Samples

Utilizing the Chapman method explained earlier, the formula was applied as follows:

$$N = \frac{n1 \times n2}{n3}$$

n1, Number cases in FirstWatch = 73

n2, Number cases in PRMCE ED = 29

n3, Number of matches = 18

$$N = \frac{73 \times 29}{18}$$

Based on this calculation, there are approximately 118 individuals per month—or 1,416 per year—with an opioid overdose requiring medical intervention at the emergency department.

Estimating Snohomish County's Burden of Disease

With the capture-recapture process complete, it is now possible to determine the range for the number of Snohomish County residents who are either misusing opioids or have opioid use disorder. The steps for this process are as follows:

- Identify a model for calculating the disease burden estimate
- Identify the outcome to be used in the model
- Complete a special study to define the best estimate input
- Use the model to calculate disease burden.

The CDC published a policy impact report[7] that included a diagram with the relationship between different opioid crisis outcomes. Those numbers have been incorporated into the pyramid shown previously. This relationship indicates that for every death, there are 10 treatment recovery admissions, 32 emergency department visits, 132 individuals with opioid use disorder, and 825 people misusing opioids.
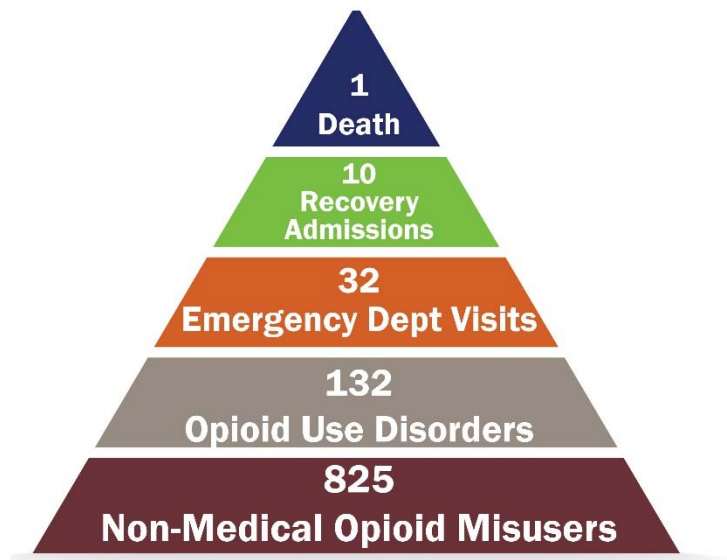
Source: Centers for Disease Control and Prevention

Since emergency department visits are the easiest outcome to measure currently, that indicator was the input collected during the capture-recapture process. By rounding the 1,416 estimated individuals visiting the PRMCE emergency department per year down to 1,400, the relationships in the pyramid were adjusted accordingly. This results is an estimate of 5,600, or 0.8% of those individuals over 11 years of age in Snohomish County having an opioid use disorder.
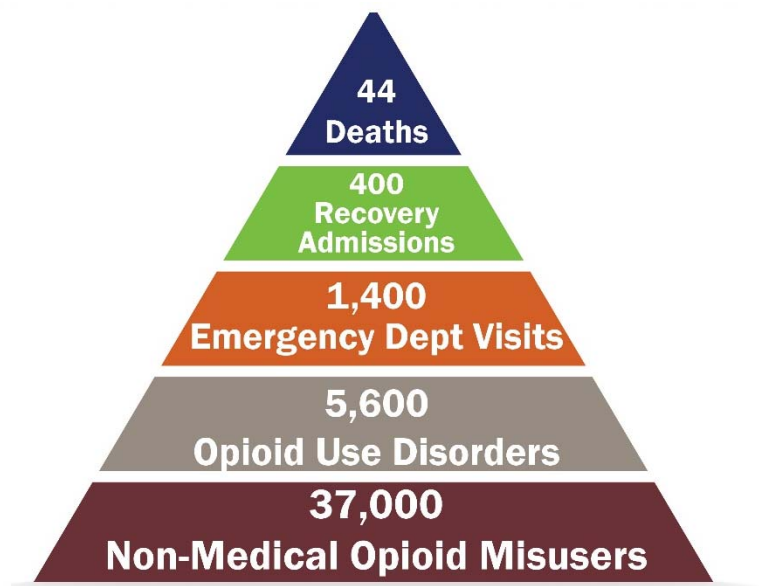
Cross-Validation of Results

In order to validate the results of this process, other independent datasets were utilized to test the model and develop ranges. These sources included the:

- 2016 National Survey on Drug Use and Health, sponsored by Substance Abuse and Mental Health Services Administration (SAMHSA). These face-to-face interviews were completed with 70,000 individuals who were 12 years or older.
- 2017 Washington State Syringe Exchange Health Survey released by the Alcohol and Drug Abuse Institute at the University of Washington.
- 2017 opioid-related death data from the Medical Examiner's Office and Washington State Department of Health.
- 2018 seven-day point-in-time study completed by the Snohomish Health District.

When using data from those sources and applying them to the CDC model used in the burden of disease calculations, the results are as follows:

Dataset	Deaths	Recovery Admissions	Emergency Dept. Visits	Opioid Use Disorder	Opioid Misusers
Burden of Disease with Capture-Recapture Method	**44**	**400**	**1,400**	**5,600**	**37,000**
2016 National Survey on Drug Use and Health	41	400	1,300	5,400	34,000
2017 Washington Syringe Exchange Health Survey	70	700	2,300	9,400	59,000
2017 Snohomish County Opioid-related Death Data	100	1,000	3,000	13,000	83,000
2018 Point-in-Time Study	90	900	3,000	12,000	80,000

This analysis validates the final burden of diseases estimates when using the capture-recapture method when applied to the CDC model.

Using some of those data sources, information was also extracted to identify the number of individuals in discrete locations who had expressed interest in pursuing treatment. That information is highlighted below:

Setting (n)	Interested	Not Interested	Refused to Answer	No Response Provided
Overdose patient transported to hospital (437)	23%	58%	13%	6%
Withdrawal watch in hospital emergency department (42)	55%	33%	7%	5%
Syringe exchange client (552)	78%	14%	-	8%

Based on this information, targeting treatment resources toward individuals either being seen in the hospital for a withdrawal watch or as a client in the local syringe exchange is worth consideration and evaluation.

Summary

The capture-recapture method estimates 1,400 emergency room visits annually for opioid-related overdoses in Snohomish County. Applying the CDC model estimates, 5,600 residents have opioid use disorder, which is consistent with other independent data sources.

Based on this, the Snohomish Health District believes that the range of residents in Snohomish County with opioid use disorder is likely between 5,000 and 10,000 individuals. Furthermore, those who misuse opioids is likely in the range of 35,000 to 80,000 people.

Next Steps

Moving forward, there are a few key tasks that would be worth completing:

- Refining the estimate of people expressing interest in entering treatment of any kind
- Determining the availability of treatment based on a survey of the current treatment landscape
- Determining if a gap exists by comparing the estimate of interest to the availability of treatment services
- Exploring gaps in case management and the need for more wrap-around services.

Sources

1) American Psychiatric Association. (2013). Substance-related and addictive disorders. In *Diagnostic and statistical manual of mental disorders (5th ed.).* (DSM-5). Retrieved from http://dsm.psychiatryonline.org/book.aspx?bookid=556.

2) University of Idaho. WLF 448: Fish & Wildlife Population Ecology 2008. Available at: http://www.webpages.uidaho.edu/wlf448/cap_recap.htm

3) Chapman DG. *Some Properties of the Hypergeometric Distribution with Applications to Zoological Sample Censuses.* University of California Publications in Statistics. Berkeley and Los Angeles, CA: University of California Press. 1951;1(7)131-160.

4) University of Manitoba. Concept: Capture-Recapture Method of Estimating Population Size. http://mchp-appserv.cpe.umanitoba.ca/viewConcept.php?printer=Y&conceptID=1469

5) Chartier M, Dart A, Tangri N, Komenda P, Walld R, Bogdanovic B, Burchill C, Koseva I, McGowan K-L, Rajotte L. *Care of Manitobans Living with Chronic Kidney Disease.* Winnipeg, MB: Manitoba Centre for Health Policy, 2015. [Report]

6) Joshua A. Barocas et al. "Estimated Prevalence of Opioid Use Disorder in Massachusetts, 2011–2015: A Capture–Recapture Analysis," *American Journal of Public Health* 108, no. 12 (December 1, 2018): pp. 1675-1681.

7) Centers for Disease Control and Prevention, *Policy Impact: Prescription Pain Killer Overdoses.* Available at: https://www.cdc.gov/drugoverdose/pdf/policyimpact-prescriptionpainkillerod-a.pdf.

8) Center for Behavioral Health Statistics and Quality. (2017). 2016 National Survey on Drug Use and Health: Detailed Tables. Substance Abuse and Mental Health Services Administration. Available at: https://www.samhsa.gov/data/sites/default/files/NSDUH-DetTabs-2016/NSDUH-DetTabs-2016.pdf

9) Banta-Green CJ, Newman A, Kingston S. Washington State Syringe Exchange Health Survey: 2017 Results. Alcohol & Drug Abuse Institute, University of Washington, January 2018. Available at: http://adai.uw.edu/pubs/pdf/2017syringeexchangehealthsurvey.pdf