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Integrating Qualitative and Quantitative Data Analysis for Detecting Counterfeit Opioids for Poison Center Surveillance System

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Agenda

Objective

Methods
- **Sampling**
- **Natural Language Processing (NLP)**
- **Machine Learning (ML)**

Results

Key takeaways

Questions

Introduction

Background and Objectives

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Background

- The US opioid crisis continues to evolve and is currently being driven by counterfeit opioids (Ciccarone, 2021)

- Counterfeit opioids are defined as a potentially illicitly manufactured substance made to look like a legitimate opioid medication

  - Counterfeits opioids include any opioids not manufactured by a pharmaceutical company and include illicit fentanyl, fentanyl analogs and other novel synthetic opioids

  - Present increased risk of overdose due to higher potency and shorter half life compared to pharmaceutical opioids (Daniulaityte et al., 2022)

- **Identifying exposures that may involve counterfeit opioids or imitations within the PC program allows for these exposures to be characterized and compared to those not involving a counterfeit medication**

Ciccarone, 2021: https://pubmed.ncbi.nlm.nih.gov/33965972/

Daniulaityte et al., 2022: https://pesquisa.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/resource/fr/covidwho-1866364

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Objective

Develop a method leveraging existing qualitative information

Quantify the impact of counterfeit opioids on rates of opioid exposure

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Data Source: RADARS® System Poison Center Program

- Spontaneous reports to poison centers from general population and healthcare providers
- Data collected by poison centers by case documentation
- Drug queried for cases involving drugs of interest

Coverage:
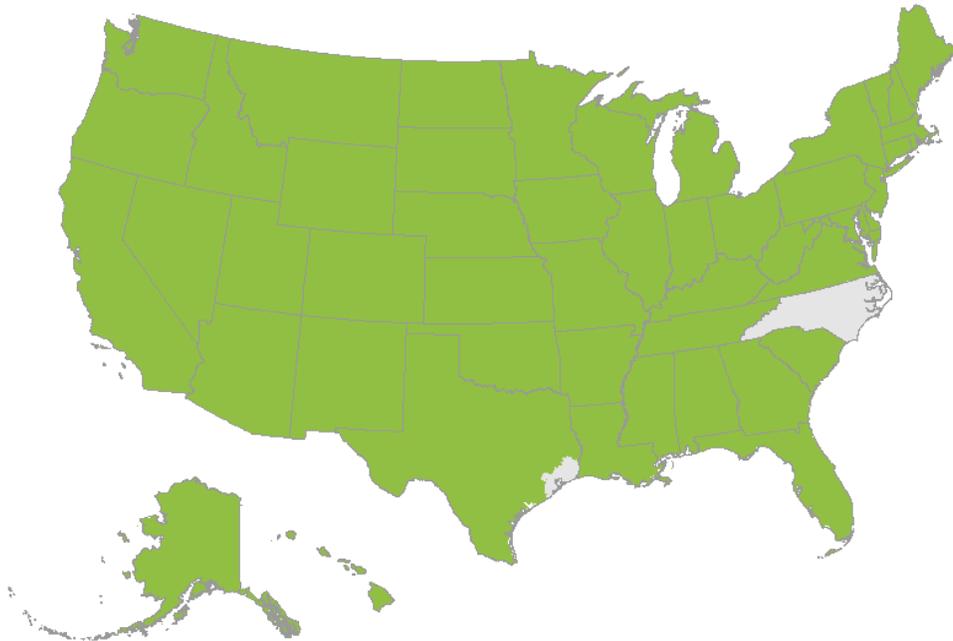
POISON Help®
1-800-222-1222

Coverage

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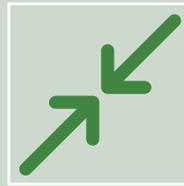
Methods—Sampling

What? 1,000 case notes

Who? Intentional opioid exposures

When? 2017-2021

How? Targeted selection to up-weight illicits. Manually reviewed and coded.

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Example of a Case Note

Thu Sep 16, 2021 @ 14:00 xxxx:xxxxxxxx --- XXXXX has a Dad in XX telling them about his son in XXXXXXXXXXX 17 yo male on Tuesday night took some sort of pill laced with Fentanyl (dad later said Percocet likely laced with Fentanyl) and drank some ETOH , became unresponsive and blue Tuesday eve when EMS was called - gave 3 doses Narcan and took to XXXXXXXX ER. He was discharged 3 hours later Last night - son was with girlfriend when he had snoring respirations and then stopped breathing , she gave another dose of narcan and he is at work now - asympt. XXXXX unsure if XX hospital called us- will have dad talk to us to refer on or track the Percocet/ fentanyl pill XX PCC talked with dad. Dad XXXX XXXXXXXXXXXX Above history discussed He is very angry with XXXXXXXX hospital for letting son go home after a few hours. A: percocet : APAP 325mg / oxycodone 2.5-10mg fentanyl - unknown amount s/s : cns and resp depression ethanol - unknown amount : increased CNS / resp depression possible * return of resp depression can occur when naloxone wears off . Best to monitor 4-6 hours after minimum but amount of Fentanyl in street drug hard to predict per history son reportedly only took 1 with ETOH REc: We would rec ER since symptoms recurred and had to use naloxone again. Dad doesn't like the idea of going back to XXXXXXXX hospital. Since son is asympt now - pcc recs at the very least he really should be evaluated by an MD - personal physician? Dad will check with his mom to see if MD can see him , or could go to another HCF.

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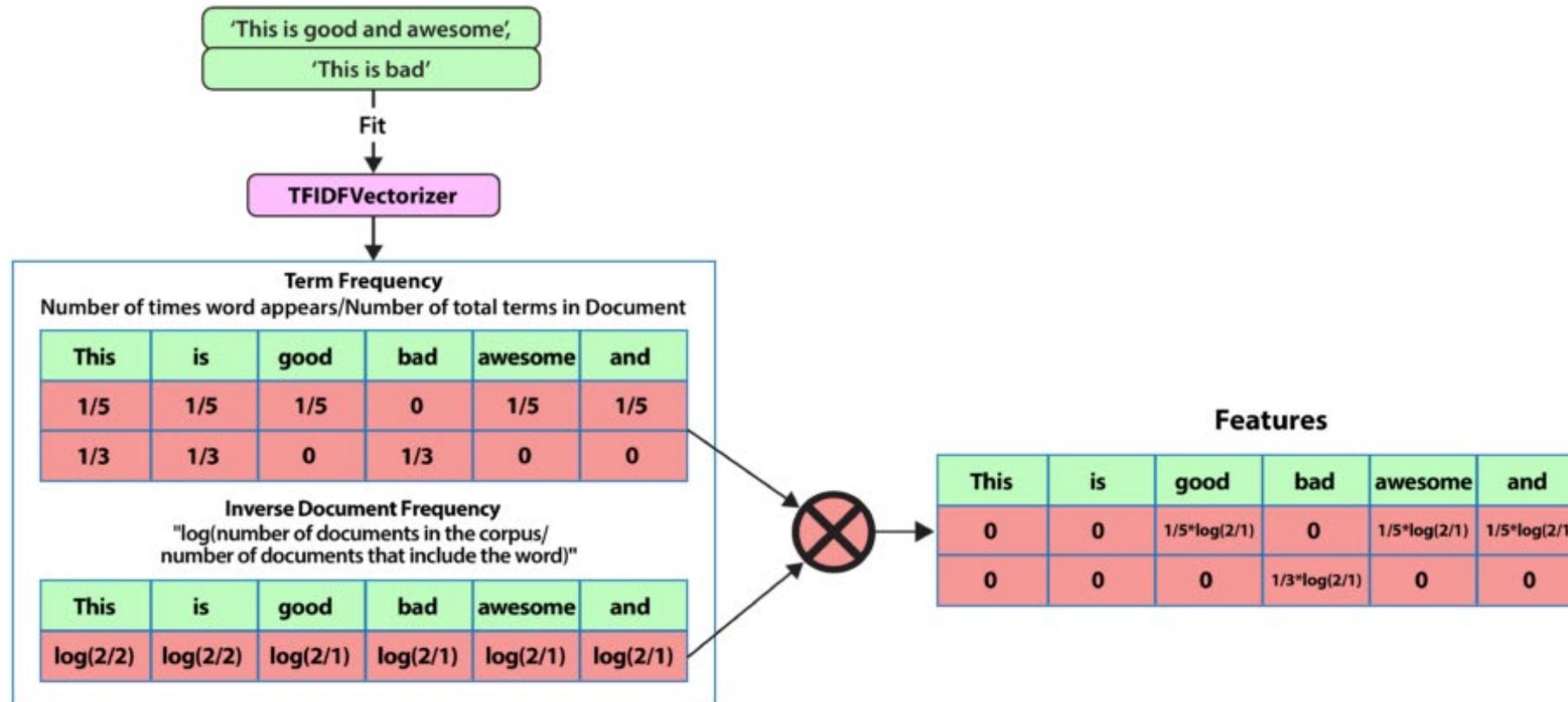Saving lives with answers.™

Methods—Natural Language Processing (NLP)

- The conversion of written natural human language into structured and minable data through the combination of linguistic, statistical and machine learning methods
- Raw text representing human language is converted into structured quantitative data
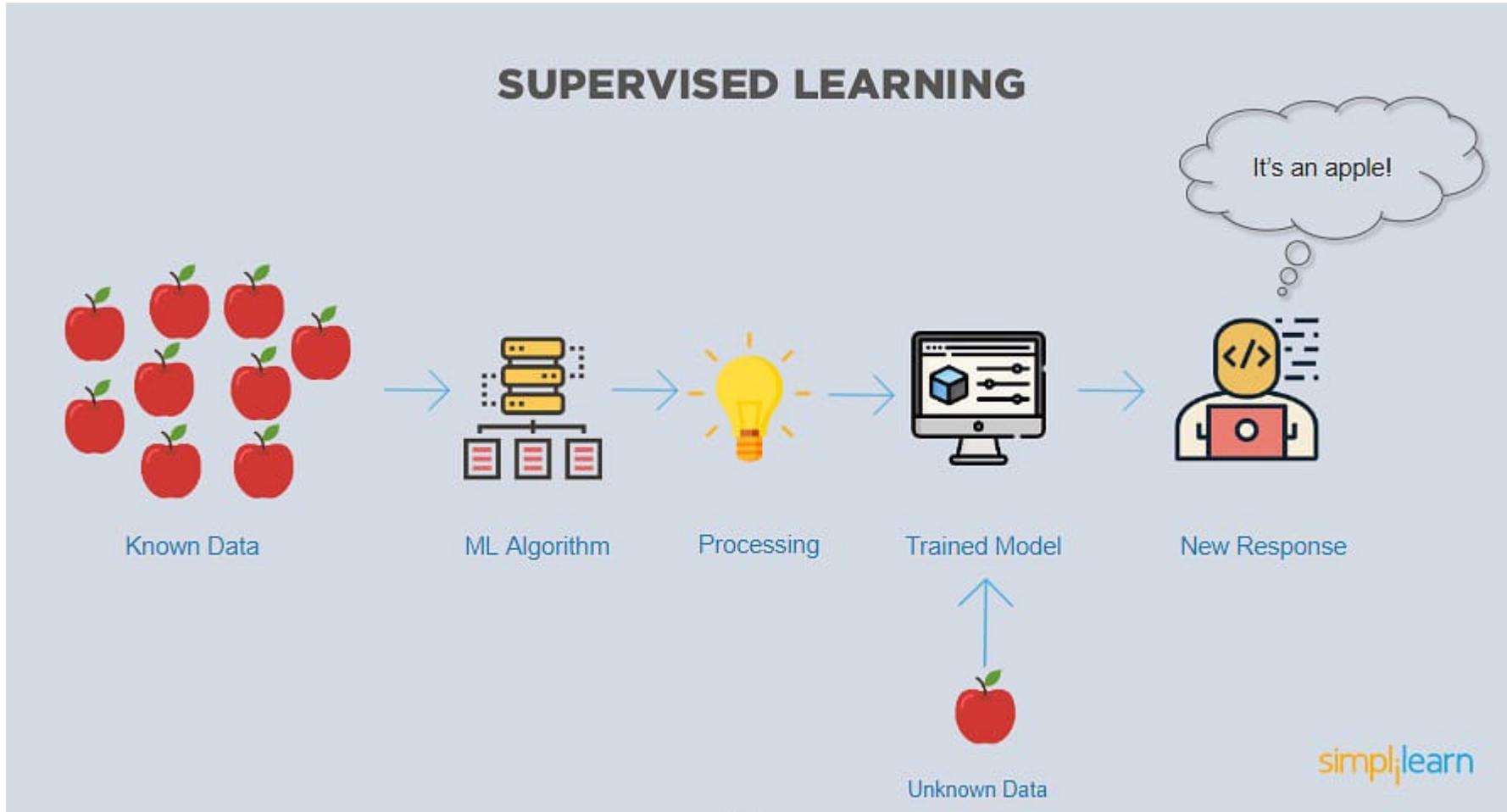- NLP Converts qualitative information into quantitative data

Qualitative → NLP → Quantitative

Fanni, S.C., Febi, M., Aghakhanyan, G., Neri, E. (2023). Natural Language Processing. In: Klontzas, M.E., Fanni, S.C., Neri, E. (eds) Introduction to Artificial Intelligence. Imaging Informatics for Healthcare Professionals. Springer, Cham. https://doi.org/10.1007/978-3-031-25928-9_5

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- Term frequency-inverse document frequency (TF-IDF) is a relative measure of how often each term shows up in the casenotes of a particular exposure compared to the frequency in the overall collection of casenotes from all exposures

Figure credit: https://mlwhiz.com/blog/2019/02/08/deeplearning_nlp_conventional_methods/

Methods—Machine Learning

Image ref: https://www.simplilearn.com/tutorials/machine-learning-tutorial/what-is-machine-learning

Results

Natural Language Processing and Machine Learning

Results— Natural Language Procession

Overall
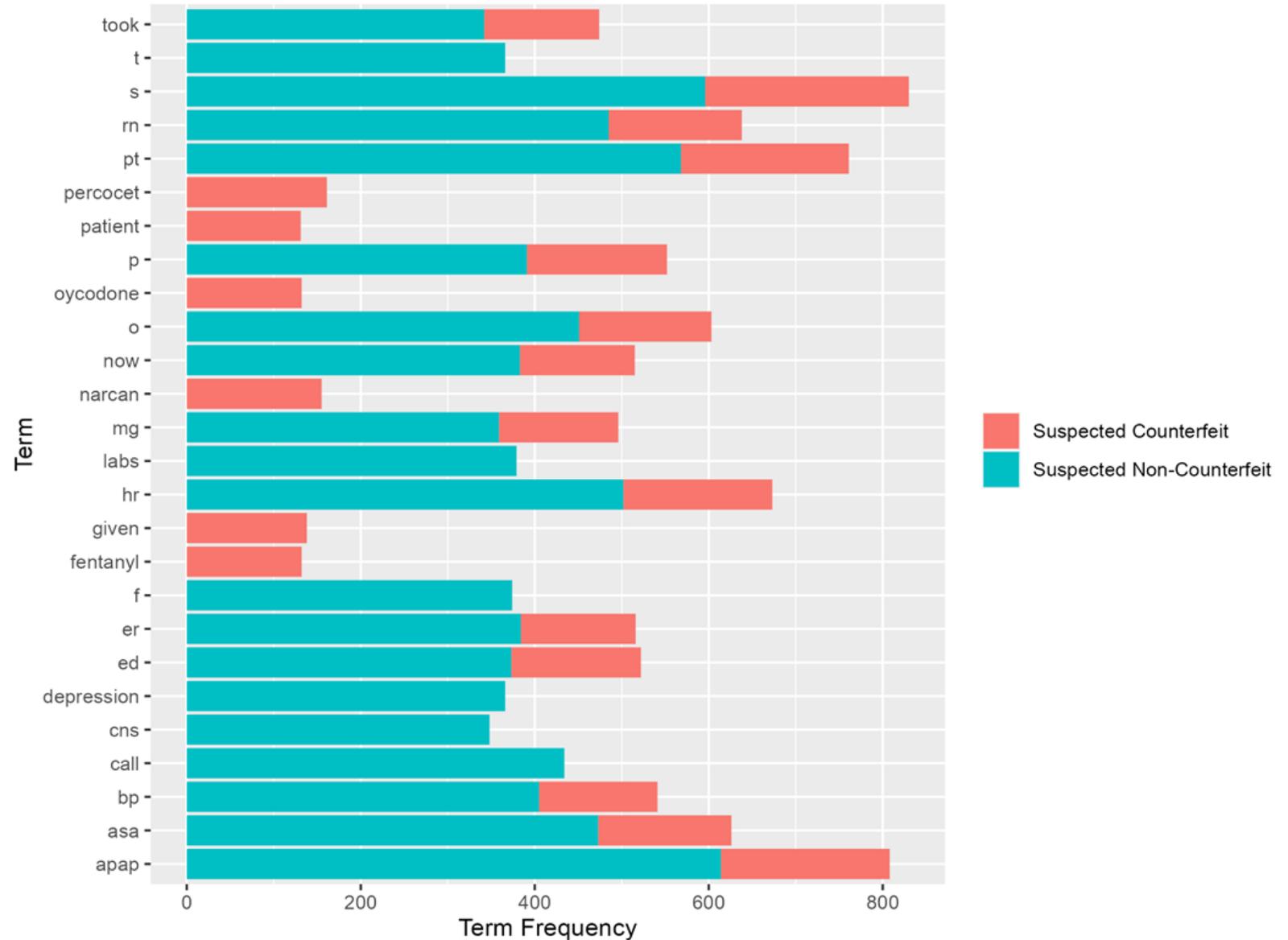- S
- APAP
- Pt

Among Suspected Counterfeits
- Percocet
- Narcan
- Oxy

Among Suspected Non-counterfeits
- Bp
- F
- T
- Depression
- CNS

Figure 3: Frequency of Most Common Words Among Suspected Counterfeit and Suspected Non-Counterfeit Cases
RADARS® System Poison Center Program – Sampled Data
1st Quarter 2017 - 4th Quarter 2021

Impact on Opioid Analgesics

Intentional Abuse Exposures by Aggregate Drug Group and Year
RADARS® System Poison Center Program
2017- 2021

Year	All Opioid Analgesics Combined	Suspected Counterfeits	Percent Difference with Counterfeits Removed
2017	2,619	161	6%
2018	1,982	194	10%
2019	1,981	344	17%
2020	2,708	776	29%
2021	2,401	798	33%

Total number of suspected counterfeits: 2,273 (19%)

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Impact on Population Rates

Intentional Abuse Population Rate by Year (per 100,000 Person-Years)
RADARS® System Poison Center Program
2017-2021
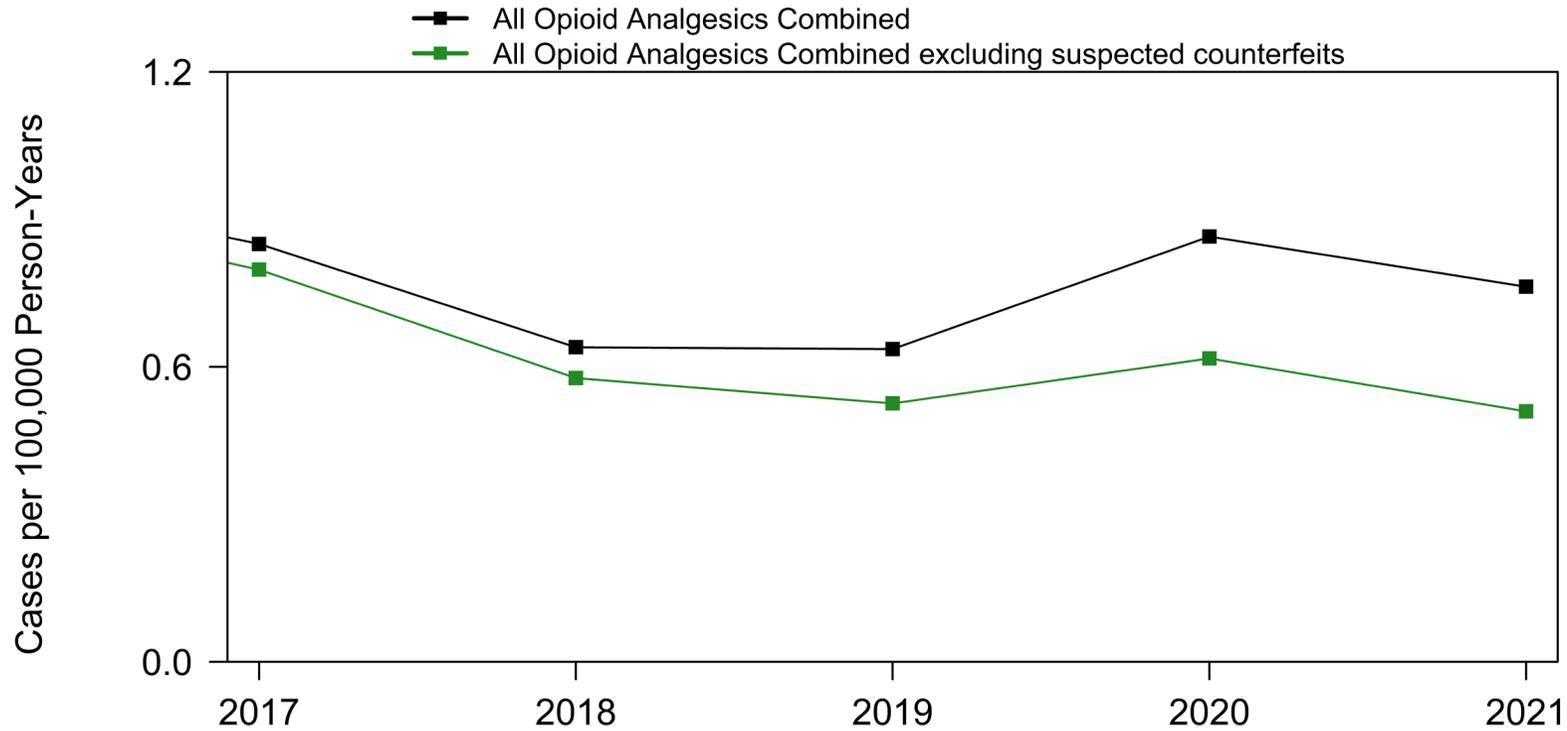
In 2021,

0.76 (0.73, 0.79)

⬇

0.51 (0.48, 0.53)

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Conclusions

Piloted a detection system that combines qualitative and quantitative methods to address a complex public health problem

We show why it is important to consider counterfeit misclassification in data collection

Lessons Learned

Sampling assumptions translate to result implications

Project management

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