Text Analysis of Death Certificate Records to Ascertain Drugs Involved in Deaths in the National Vital Statistics System

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Introduction: NCHS and NVSS

- National Center for Health Statistics (NCHS) provides statistical information that guides actions and policies to improve the health of the American people
- National Vital Statistics System (NVSS) encompasses the processing and coding of birth and death certificate records from 57 jurisdictions*
  - Cause-of-death (ICD-10) codes are assigned to death data received by jurisdictions at NCHS
  - Data are coded, processed and then disseminated for health statistics, surveillance and research

*50 states, New York City, District of Columbia and 5 US territories (American Samoa, Guam, Norther Marianas, Puerto Rico, and Virgin Islands)
Data Source: Death Certificate

Demographic information
Completed by the funeral director using information from the best qualified person: spouse, parent, child, another relative, or other person who has knowledge of the facts

Medical information
For natural causes, completed by attending physician, nurse practitioner, physician’s assistant
For sudden and unexplained deaths, completed by medical examiner, coroner, Justice of the Peace

Demographic information
U.S. Standard Death Certificate: Cause-of-Death Section

Referred to as the **literal text:**
- the information written by the medical certifier on the cause, manner, circumstances, and other factors contributing to the death
  - Part I – Chain of events that directly caused the death
  - Part II – Significant conditions contributing to death
  - Box 43 – Describe how the injury occurred
Drug Overdose Death Rates, United States, 1999-2017

Deaths per 100,000 standard population

1999 2001 2003 2005 2007 2009 2011 2013 2015 2017

T40.1 Heroin
T40.2 Natural and semisynthetic opioids
T40.3 Methadone
T40.4 Synthetic opioids other than methadone

Drug Overdose Death Rates, United States, 1999-2017

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Examples of common drugs found on death certificates without specific ICD-10 code

Opioids
- Fentanyl
- Fentanyl analogs
- Oxycodone
- Hydrocodone
- Morphine
- Hydrocodone
- Tramadol

Stimulants
- Methamphetamine
- MDMA

Benzodiazepines
- Alprazolam
- Diazepam
- Clonazepam

<table>
<thead>
<tr>
<th>Opioids</th>
<th>Stimulants</th>
<th>Benzodiazepines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fentanyl</td>
<td>Methamphetamine</td>
<td>Alprazolam</td>
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<tr>
<td>Fentanyl analogs</td>
<td>MDMA</td>
<td>Diazepam</td>
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<tr>
<td>Oxycodone</td>
<td></td>
<td>Clonazepam</td>
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<td>Hydrocodone</td>
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<td>Morphine</td>
<td></td>
<td></td>
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<tr>
<td>Hydrocodone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tramadol</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3-Methylfentanyl  
4-ANPP
4-MeO-Butyrylfentanyl
Acetylfentanyl
Acrylfentanyl
Acryloylfentanyl
Alfentanil
Butyrylfentanyl
Carfentanil

Despropionyl-fentanyl
Furanyl fentanyl
Methylnaltrexone
Para-fluorobutyrylfentanyl
Para-fluoroisobutyrylfentanyl
P-Fluoro-butyrylfentanyl
Remifentanil
Sufentanil
...

...
Methods to Identify Specific Drugs on Death Records

- Collaboration between NCHS and FDA

- Developed methods to analyze literal text for mentions of specific drugs
  - Preprocessed text (e.g., remove stop words, special characters)
  - Examined and reviewed string terms and phrases
  - Categorized terms into categories (i.e., principal variants)
  - Considered context (e.g., “history of”, “insulin-dependent”)

- Referred to as the Drugs Mentioned with Involvement (DMI) methodology

¹ Drugs Mentioned with Involvement (DMI) methodology: https://www.cdc.gov/nchs/data/nvsr/nvsr65/nvsr65_09.pdf
## Selected Results

<table>
<thead>
<tr>
<th>Rank</th>
<th>Referent Drug</th>
<th># of deaths</th>
<th>Referent Drug</th>
<th># of deaths</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Oxycodone</td>
<td>5,587</td>
<td>Fentanyl</td>
<td>18,335</td>
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<tr>
<td>2</td>
<td>Cocaine</td>
<td>5,070</td>
<td>Heroin</td>
<td>15,961</td>
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<td>3</td>
<td>Heroin</td>
<td>4,571</td>
<td>Cocaine</td>
<td>11,316</td>
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<tr>
<td>4</td>
<td>Methadone</td>
<td>4,545</td>
<td>Methamphetamine</td>
<td>6,762</td>
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<tr>
<td>5</td>
<td>Alprazolam</td>
<td>4,066</td>
<td>Alprazolam</td>
<td>6,209</td>
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<td>6</td>
<td>Morphine</td>
<td>3,290</td>
<td>Oxycodone</td>
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<td>7</td>
<td>Hydrocodone</td>
<td>3,206</td>
<td>Morphine</td>
<td>5,014</td>
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<td>8</td>
<td>Methamphetamine</td>
<td>1,887</td>
<td>Methadone</td>
<td>3,493</td>
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<td>9</td>
<td>Diazepam</td>
<td>1,698</td>
<td>Hydrocodone</td>
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<td>10</td>
<td>Fentanyl</td>
<td>1,662</td>
<td>Diazepam</td>
<td>2,022</td>
</tr>
</tbody>
</table>


Considerations and Next Steps

- Literal text analyses can enable researchers to report with more granularity, the specific drugs involved in deaths

- Challenges
  - Identification of specific drugs is dependent on testing, interpretation and reporting by death certifiers
  - Temporal changes in reporting of the specific drugs can impact trends analyses

- Future steps
  - Automate these processes (e.g., machine learning), while recognizing that we must also identify terms that appear a small number of times
Questions?

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