Using Literal Text from Death Certificates to Identify the Drugs Involved in Drug Overdose Deaths

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Recent Reports from the National Center for Health Statistics


Age-adjusted Rates for Drug Poisoning Deaths by Type of Drug, United States, 1999-2015

Deaths per 100,000 population, age-adjusted to the 2000 U.S. standard population.
Drug poisoning deaths are counted by ICD-10 under the cause of death T40.0, T40.1, T40.2, T40.3, T40.4, T40.5, T40.6, T40.7, and T40.8.1-3


Limitations of ICD-10 for drug poisoning

• Few codes for individual drugs (e.g., T40.1 Heroin, T40.3 Methadone, T40.5 Cocaine)
• Most codes are for broad categories of drugs (e.g., T40.2 Other opioids, T40.4 Other synthetic narcotics)
• Therefore, difficult to use ICD-10 coded data to monitor trends in deaths involving specific drugs not uniquely classified in ICD-10

Development of Methods for Literal Text Analysis for Drug-involved Deaths

• Collaboration between National Center for Health Statistics (NCHS) and Food and Drug Administration (FDA)
• Use literal text from death certificates to identify drugs involved in deaths
  – Literal text = the words entered on the death certificate by the medical certifier

U.S. Standard Death Certificate

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

Medical
Completed by physician, nurse practitioner, physician’s assistant for natural causes
Completed by medical examiner, coroner, justice of the peace for sudden and unexplained deaths

Demographic
Considerations in Developing the Methods for Literal Text Analysis

- Availability of literal text information
- Structure of the literal text
  - Syntax
  - Relationship among the four text fields in Part 1
    - Case, symbols and numbers (special characters)
- Drug information
  - Specificity, synonyms, misspellings
- Contextual information

Availability of Literal Text Information

The literal text was considered uninformative if:
- there was no text in any of the three literal text fields
- the fields only contained descriptive words or phrases about the status of the investigation (e.g., mentions of “PENDING” or “UNDER INVESTIGATION”)

Deaths with no informative literal text on cause of death, 2013

<table>
<thead>
<tr>
<th>Number of deaths</th>
<th>Percent of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>All deaths</td>
<td>2,596,993</td>
</tr>
<tr>
<td>Deaths with no informative literal text</td>
<td>1,831</td>
</tr>
</tbody>
</table>

Syntax, Order and Special Characters

- Syntax of literal text
  - Generally a few words or simple phrases rather than complete clauses or sentences
- Four text fields in Part 1 of the death certificate
  - The concept of “As a consequence of...” was ignored
  - Concatenated into a single text field
- Case, symbols and numbers (special characters)
  - Convert to upper case; remove symbols and numbers

Development of the Drug Search Term List

- List of single word generic names
  - Substance Abuse and Mental Health Services Administration (SAMHSA) Drug Abuse Warning Network (DAWN) Drug Reference Vocabulary (DRV) 2012 (based on Multum Lexicon database)
  - DRUGS@FDA website for brand name drugs
  - FDA Adverse Event Reporting System data for misspellings
  - Non-systematic manual reviews and queries of the literal text
- Currently, the search term list includes >3,000 search terms representing >1,600 principal variants

Specificity of Drug Information

- Literal text on the death certificate may mention:
  - Specific drugs (e.g., “OXICODONE” or “FENTANYL”)
  - Drug classes (e.g., “OPIOID”)
  - Exposures not otherwise specified (NOS) (e.g., “DRUG”, “CHEMICAL”, and “POLYPHARMACY”)
  - A combination of specific drugs, drug classes, and exposures NOS
    - e.g., “OPIOID (HEROIN) OVERDOSE”
Development of the Drug Search Term List: Categorization

- Search terms were categorized by various characteristics
  - Specific drug, a drug class, or an exposures NOS
  - Generic drug name, brand name, common use or street name, abbreviation, metabolite, or misspelling
- Search terms were mapped to a single “principal variant”
  - In general, the generic drug name
  - Some mapped to two or more principal variants (for combination drug products)

Development of the Drug Search Term List: Exclusions

- Foods and food additives (e.g., starch)
- Excipients
- Gases (e.g., helium, carbon monoxide)
- Airborne contaminants (e.g., soot)
- Industrial chemicals (e.g., ethylene glycol)
- Periodic table elements (e.g., lithium, iodine)
- Substances with unknown industrial or pharmaceutical application

Contextual Information

- Mention of a drug does not necessarily mean the drug was involved in the death
- Need contextual information to determine drug involvement
- Three lists developed using iterative manual reviews and queries of literal text of data from 2003-2014
  - Descriptors
  - Joining phrases
  - Contextual phrases

- Contextual phrases that suggested no drug involvement generally referred to health conditions or disease states
  - “INSULIN DEPENDENT DIABETES”
  - “METHICILLIN RESISTANT STAPHYLOCOCCUS AUREUS INFECTION”
  - “NO DRUG INVOLVED”

- Drugs mentioned in the literal text were assumed to be involved in the death unless contextual information suggested otherwise
- Currently, the search term list includes >500 descriptors, 22 joining phrases, and >1,600 contextual phrases

Identifying Mentions of Drugs and Ascribing Context

SAS Version 9.3 programs to:

- Remove symbols, numbers, and double-spaces, and convert all characters to uppercase
- Identify drug mentions
- Map descriptors to the drug mentions
- Replace (consecutive) drug mentions and associated descriptors with a single asterisk (for efficiency in data processing)
- Map contextual phrases to the appropriate drug mention(s)

Example of Data Processing

"Ingested illicit and Rx drugs (heroin and methadone); hx of opioid abuse"

INGESTED ILLICIT AND RX DRUGS HEROIN AND METHADONE HX OF OPIOID ABUSE

INGESTED * HX OF * ABUSE
Results from Applying the Method to Death Certificate Literal Text from 2013

<table>
<thead>
<tr>
<th>Number of Deaths</th>
<th>Number of Mentions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths among U.S. residents</td>
<td>2,596,993</td>
</tr>
<tr>
<td>Deaths with at least one drug, alcohol, tobacco, or nicotine mention</td>
<td>114,621</td>
</tr>
<tr>
<td>Deaths with at least one drug mention</td>
<td></td>
</tr>
<tr>
<td>Deaths with at least one drug mention and context indicating drug involvement in the death</td>
<td></td>
</tr>
<tr>
<td>Deaths with at least one drug, alcohol, tobacco, or nicotine mention</td>
<td>114,621</td>
</tr>
<tr>
<td>Deaths with at least one drug mention</td>
<td></td>
</tr>
<tr>
<td>Deaths with at least one drug mention and context indicating drug involvement in the death</td>
<td></td>
</tr>
</tbody>
</table>

1 Mentions of alcohol, tobacco, and nicotine were excluded; drug mentions only

SOURCE: NCHS, National Vital Statistics System, Mortality files linked with literal text data

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Top 10 Drugs Involved in Drug Overdose Deaths, 2010-2014

- **Opioids**
  - Heroin
  - Oxycodone
  - Methadone
  - Morphine
  - Hydrocodone
  - Fentanyl

- **Benzodiazepines**
  - Alprazolam
  - Diazepam

- **Stimulants**
  - Cocaine
  - Methamphetamine

SOURCE: NCHS, National Vital Statistics System, Mortality files linked with literal text data

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Number of drug overdose deaths*, by number of specific drugs involved, US, 2014

<table>
<thead>
<tr>
<th>Number of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
</tr>
<tr>
<td>Two</td>
</tr>
<tr>
<td>Three</td>
</tr>
<tr>
<td>Four</td>
</tr>
<tr>
<td>Five</td>
</tr>
<tr>
<td>More than five specific drugs</td>
</tr>
</tbody>
</table>

*Drug overdose deaths were identified using ICD-10 underlying cause of death codes of X40-X44, X60-X64, X85 or Y10-Y14

SOURCE: CDC/NCHS, National Vital Statistics System, Mortality files linked with death certificate literal text
Percent distribution of deaths involving concomitant drugs for the top 10 drugs involved in drug overdose deaths*, US 2014

<table>
<thead>
<tr>
<th>Drug</th>
<th>Percent Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fentanyl</td>
<td>25%</td>
</tr>
<tr>
<td>Heroin</td>
<td>20%</td>
</tr>
<tr>
<td>Cocaine</td>
<td>15%</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>10%</td>
</tr>
<tr>
<td>Alprazolam</td>
<td>9%</td>
</tr>
<tr>
<td>Morphine</td>
<td>8%</td>
</tr>
<tr>
<td>Methamphetamine</td>
<td>7%</td>
</tr>
<tr>
<td>Hydrocodone</td>
<td>4%</td>
</tr>
<tr>
<td>Morphine</td>
<td>3%</td>
</tr>
<tr>
<td>Diazepam</td>
<td>2%</td>
</tr>
</tbody>
</table>

*Drug overdose deaths were identified using ICD-10 underlying cause of death codes of X40-X44, X60-X64, X85 or Y10-Y14.

SOURCE: CDC/NCHS, National Vital Statistics System, Mortality files linked with death certificate literal text

Most frequent concomitant drugs for drug overdose deaths* involving selected drugs, US, 2014

<table>
<thead>
<tr>
<th>Referent Drug</th>
<th>Most frequent concomitant drug</th>
<th>2nd most frequent concomitant drug</th>
<th>3rd most frequent concomitant drug</th>
<th>4th most frequent concomitant drug</th>
<th>5th most frequent concomitant drug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fentanyl</td>
<td>Heroin</td>
<td>Cocaine</td>
<td>Oxycodone</td>
<td>Alprazolam</td>
<td>Morphine</td>
</tr>
<tr>
<td>n=4,200</td>
<td>25%</td>
<td>20%</td>
<td>15%</td>
<td>10%</td>
<td>9%</td>
</tr>
<tr>
<td>Heroin</td>
<td>n=10,863</td>
<td>Cocaine</td>
<td>Fentanyl</td>
<td>Alprazolam</td>
<td>Morphine</td>
</tr>
<tr>
<td>23%</td>
<td>20%</td>
<td>9%</td>
<td>8%</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>n=5,417</td>
<td>Alprazolam</td>
<td>Morphine</td>
<td>Morphine</td>
<td>Hydrocodone</td>
</tr>
<tr>
<td>23%</td>
<td>23%</td>
<td>11%</td>
<td>10%</td>
<td>10%</td>
<td>8%</td>
</tr>
<tr>
<td>Cocaine</td>
<td>n=5,856</td>
<td>Heroin</td>
<td>Fentanyl</td>
<td>Morphine</td>
<td>Alprazolam</td>
</tr>
<tr>
<td>37%</td>
<td>20%</td>
<td>10%</td>
<td>8%</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>Methamphetamine</td>
<td>n=3,728</td>
<td>Heroin</td>
<td>Morphine</td>
<td>Cocaine</td>
<td>Amphetamine</td>
</tr>
<tr>
<td>20%</td>
<td>20%</td>
<td>8%</td>
<td>6%</td>
<td>5%</td>
<td>4%</td>
</tr>
</tbody>
</table>

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SOURCE: CDC/NCHS, National Vital Statistics System, Mortality files linked with death certificate literal text

Continuing Work

- Public use files in the NCHS Research Data Center
- Collaboration with medical examiners/coroners/certifiers to improve the quality of information on cause of death
  - Encourage the reporting of the specific drugs involved on the death certificate
- Update the drug search term lists and contextual phrases
  - SAS Contextual Analysis software
- Modification of the SAS programs for use by state vital registrars and injury epidemiologists

Questions?

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