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Methods to Adjust Provisional Counts of Drug Overdose Deaths for Underreporting

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Abstract

Objectives—This report describes the completeness of provisional drug overdose death data from the National Center for Health Statistics' mortality surveillance program and evaluates methods to adjust provisional counts of drug overdose deaths for delayed reporting.

Methods—Provisional data (captured weekly from February 28, 2016, through July 4, 2017) for drug overdose deaths were compared with final counts to determine the percentage of drug overdose death records available in the surveillance database (i.e., completeness) after a 6-month lag. Linear models were used to predict completeness, based on the month of death, the percentage of death records with manner of death reported as "pending investigation," and accounting for clustering by jurisdiction of occurrence. Results were used to develop adjustments to provisional counts of drug overdose deaths to account for delayed reporting.

Results—After a 6-month lag, completeness of provisional counts of drug overdose deaths ranged from 92% to 98% for the United States by month, and from 77% to 100% by jurisdiction. The percentage of death records with manner of death pending investigation in provisional data for 2017 ranged from 0.18% to 0.33% for the United States, and was higher in more recent months. After adjustment for delayed reporting, predicted provisional counts of drug overdose deaths were higher than reported counts, and the differences were larger for more recent months.

Conclusion—Provisional counts of drug overdose deaths can be adjusted to account for delayed reporting of cause and manner of death based on historical patterns, and these adjustments may reduce the likelihood that recent trends the provisional counts of drug overdose deaths will be misinterpreted. Even with reporting delays, provisional counts of drug overdose deaths can provide more timely information about the burden of drug overdose mortality across the United States and where drug overdose mortality is increasing rapidly.

Keywords: drug overdose mortality • provisional mortality data • National Vital Statistics System • Vital Statistics Rapid Release

Introduction

The National Center for Health Statistics (NCHS) collects and disseminates the country's official birth and death statistics through the National Vital Statistics System (NVSS). Through NVSS, 57 jurisdictions (including the 50 states, New York City, the District of Columbia, and 5 U.S. territories) send birth and death data to NCHS. The NVSS surveillance program was initiated by NCHS to provide more timely access to vital statistics data for the purposes of conducting public health surveillance of key indicators from provisional birth and death data (1–3).

A recent report described the timeliness of mortality data by cause of death, finding that lag times between when the death occurred and when the data were available for analysis in the NVSS surveillance database were longer for deaths due to drug overdose than for other causes of death, such as heart disease (4). Drug overdose deaths often require lengthy investigations, including toxicological analysis, and death certificates may be filed initially with a manner of death "pending investigation" or with a preliminary or unknown cause of death. On average, provisional counts of drug overdose deaths were 83% complete after 6 months and 95% complete within 9 months (4).

In September 2017, NCHS began releasing provisional 12-month ending counts of drug overdose deaths for the purposes of public health surveillance (5). The "Provisional Drug Overdose Death Counts" data visualization is updated monthly and includes: (a) the provisional counts of deaths due to drug overdose occurring nationally and in each jurisdiction; (b) the provisional counts of drug overdose deaths involving specific drugs or drug classes occurring nationally and in selected jurisdictions; (c) a U.S. map of the percentage change in provisional drug overdose deaths for the current 12-month ending period compared with the 12-month period ending in the same month of the previous year, by jurisdiction. Provisional counts of drug overdose deaths are presented with a 6-month lag (e.g., data for the 12-month period ending with September 2017 were published in early April 2018).

Even with this lag, provisional counts of drug overdose deaths are underestimated relative to final counts. The degree of underestimation is determined primarily by the percentage of records with the manner of death reported as pending investigation and tends to vary by reporting jurisdiction, year, and month of death. Specifically, the number of drug overdose deaths will be underestimated to a larger extent in jurisdictions with higher percentages of records reported as pending investigation, and this percentage tends to be higher in more recent months.

Given the importance of monitoring trends and geographic variation in drug overdose mortality across the United States, a better understanding of the completeness of provisional drug overdose mortality data is critical for interpreting trends and patterns. Additionally, the development of methods to adjust provisional counts may reduce the likelihood that provisional data will be misinterpreted, such as showing evidence of declining trends, when observed decreases in provisional numbers of deaths may be largely due to delayed reporting or incomplete data.

This report describes the completeness of provisional counts of drug overdose deaths from NCHS' mortality surveillance program and methods to adjust these provisional counts for delayed reporting.

Methods

In late 2014, as a component of the Vital Statistics Rapid Release mortality surveillance program, NCHS began systematically taking snapshots of its NVSS mortality data at the close of each week. These provisional data sets include data on all of the death records available for analysis in the NVSS surveillance database each week, capturing the underlying causes of death, dates of death, and select demographic information for all death records received from state vital records offices. Multiple-cause-of-death codes were first added to the surveillance database on February 28, 2016, enabling the analysis of specific drugs and drug categories in addition to overall drug overdose mortality. Weekly provisional mortality data captured from February 28, 2016, through July 4, 2017 (approximately 6 months after the full 2016 data year) were used to calculate the number of drug overdose deaths occurring in 2015–2016 available for analysis in the NVSS surveillance database. Final mortality data from 2015 and 2016 (6,7) were used to compare with provisional data.

Drug overdose deaths were identified using underlying cause-of-death codes from the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* (ICD–10) (8): X40–X44 (unintentional drug overdose), X60–X64 (suicide by drug overdose), X85 (homicide by drug poisoning), and Y10–Y14 (drug poisoning of undetermined intent). Drug overdose deaths involving selected drug categories were identified by specific ICD–10 multiple cause-of-death (MCOD) codes. Drug categories include: heroin (T40.1); natural opioid analgesics, including morphine and codeine, and semisynthetic opioids, including drugs such as oxycodone, hydrocodone, hydromorphone, and oxymorphone (T40.2); methadone, a synthetic opioid (T40.3); synthetic opioid analgesics other than methadone, including drugs such as fentanyl and tramadol (T40.4); cocaine (T40.5); and psychostimulants with abuse potential, which includes methamphetamine (T43.6). Opioid overdose deaths were identified by the presence of any of the following MCOD codes: opium (T40.0); heroin (T40.1); natural opioid analgesics (T40.2); methadone (T40.3); synthetic opioid analgesics other than methadone (T40.4); or other and unspecified narcotics (T40.6). This latter category includes drug overdose deaths where 'opioid' was reported without more specific information to assign a more specific ICD–10 code (T40.0–T40.4) (9,10).

Adjustments for delayed reporting

Linear regression models were used to predict the completeness of provisional data relative to final data (i.e., the percentage of drug overdose death records available in provisional data). Models included the 12-month ending period and the percentage of death records with manner of death reported as pending investigation as covariates. Since the completeness of provisional data and percentage pending are correlated across weekly provisional data sets within reporting jurisdictions, models accounted for this correlation by jurisdiction using a generalized estimating equation approach with an exchangeable correlation structure.

$$Y_{it} = \frac{\text{Provisional Count}_{it}}{\text{Final Count}_{it}} \bullet 100$$

$$E\left(Y_{it}\right) = a + B_{1t} * Month_t + B_2 \bullet PercentPending_{it}$$

Y_{it} represents the completeness of provisional data relative to final data for jurisdiction *i* for the 12-month period ending in month *t*, modeled as a function of an overall intercept,*a*, a set of indicator variables for the ending month of the 12-month reporting period, and the percentage of records with manner of death pending investigation for jurisdiction *i* in the 12-month period ending in month *t*.

This model was estimated for the following eight drug overdose outcomes of interest:

1. Drug overdose deaths
2. Drug overdose deaths involving opioids
3. Drug overdose deaths involving heroin
4. Drug overdose deaths involving natural and semisynthetic opioids
5. Drug overdose deaths involving methadone
6. Drug overdose deaths involving synthetic opioids excluding methadone

7. Drug overdose deaths involving cocaine
8. Drug overdose deaths involving psychostimulants with abuse potential

Coefficients from these models were used to develop multiplication factors (11) based on the 12-month ending period and percentage of records pending investigation for each of the eight drug outcomes of interest. Multiplication factors have been used in prior analyses and public health surveillance efforts to adjust for underreporting of various infectious disease outcomes (11–16), and similar approaches have been used to adjust for reporting delays in the surveillance of cancer incidence (17–19). Predicted provisional counts of each of the drug overdose outcomes were calculated by multiplying the reported provisional counts by the estimated multiplication factors.

$$MultiplicationFactor_{it} = \frac{1}{\hat{Y}_{it}},$$

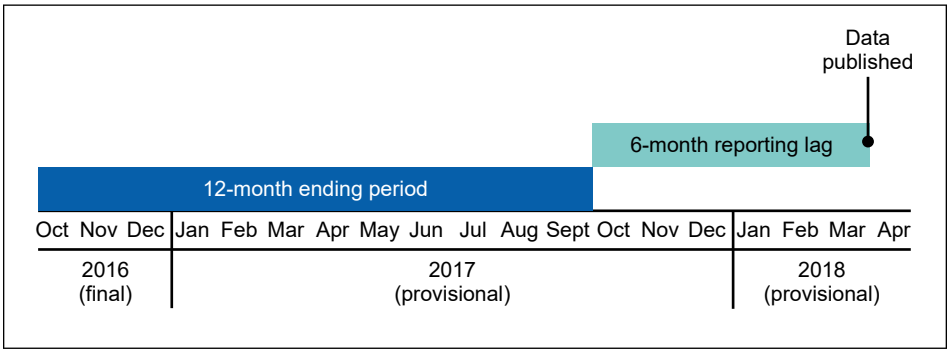
where $\hat{Y}_{it}$ is expressed as a proportion.

$$Predicted\ Count_{it} = \text{Provisional Count}_{it} \bullet Multiplication\ Factor_{it}$$

Predicted provisional counts of drug overdose deaths

To illustrate the impact of adjusting provisional counts for delayed reporting, reported and predicted provisional counts of drug overdose deaths were calculated for 12-month ending periods from January 2015 through the most recent time period (September 2017). Similar to the "Provisional Drug Overdose Death Counts" data visualization (5), estimates for 2015 and 2016 are based on final data, while estimates for 2017 are based on provisional data available as of April 15, 2018. Figure 1 illustrates how the 12-month ending provisional counts include both final data and provisional data, and are generated after a 6-month lag following the end of the 12-month period.

Figure 1. Provisional 12-month ending data period with a 6-month reporting lag



SOURCE: NCHS, National Vital Statistics System.

Because a small percentage of records remain in the final historical data with the manner of death pending investigation, adjustments were also made to final data for the percentage of records pending investigation to ensure consistency in the predicted counts over time. Failing to adjust final data could create abrupt changes in trend lines, particularly for some jurisdictions where the percentage of death records pending investigation is higher than others.

For final data periods (2015–2016), adjustments were based on a similar set of models as described above, however, the models included only the percent pending investigation variable and did not include month-ending indicator variables. This approach assumes that there is some degree of underreporting of drug overdose deaths in the final data, and that the relationships between the percentage of records pending investigation and the degree of underreporting of drug overdose deaths in the final data is the same as in the provisional data. This assumption was necessary since it is unknown how many of the death records pending investigation in the final historical data are drug overdose deaths.

Evaluation of the adjustment

To determine how well the predicted estimates account for potential reporting delays, observed and predicted provisional counts of drug overdose deaths for the 12-month period ending with January 2017 were calculated based on weekly provisional data as of July 2, 2017 (i.e., with a 6-month lag). Updated estimates for this same 12-month ending period were calculated based on provisional data as of April 15, 2018, providing a nearly 15-month lag (Figure 2). The predicted provisional counts with a 6-month lag were then compared with the observed provisional counts with a 15-month lag to determine if the adjustment methods adequately accounted for reporting delays. Although data for 2017 have not yet been finalized, data should be nearly complete after a 15-month lag, and so can be used to determine how well the predicted provisional counts will match updated or final estimates.

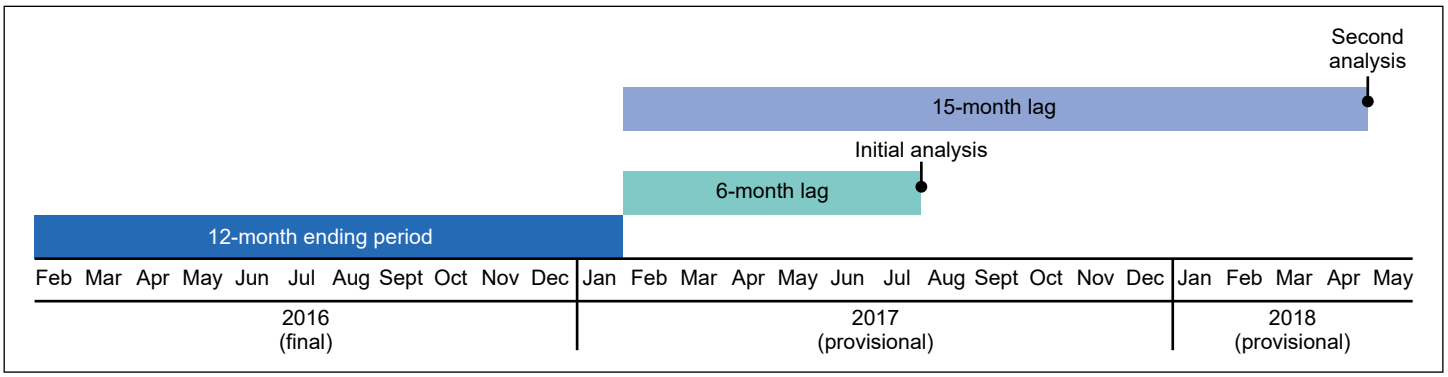
Results

Completeness of provisional drug overdose death counts

Relative to final data, 12-month ending provisional counts of drug overdose deaths were 93% to 98% complete after a 6-month lag, depending upon the month in which the 12-month period ended (Figure 3). The degree of underestimation was largest for 12-month periods ending in July or August, where provisional counts were approximately 93% to 94% of final counts, on average.

The degree of underestimation also varied by reporting jurisdiction (Table 1). For the 12-month ending periods ending in July (when completeness is generally lowest), completeness of provisional counts relative to final counts ranged

Figure 2. Provisional 12-month ending data period with a 6-month and 15-month lag



SOURCE: NCHS, National Vital Statistics System.

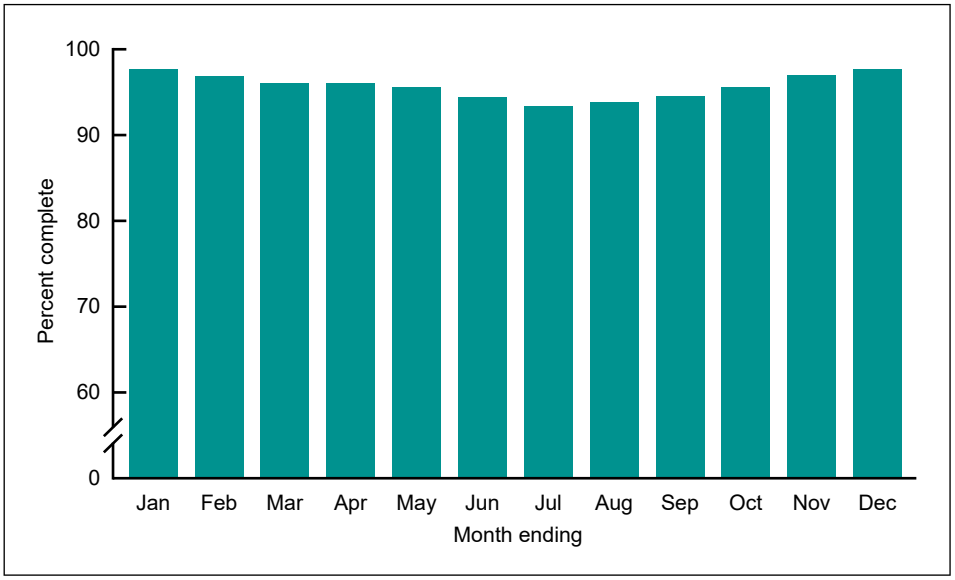
from lows of 77% (New York, excluding New York City), 78% (New Mexico), and 80% (Mississippi), to more than 99% for Oklahoma, Virginia, Minnesota, Maine, and Alaska.

Model results

In general, the model results were fairly consistent across the different drug outcomes of interest, with some exceptions (Tables 2 and 3). The percentage of records with the manner of death pending investigation was consistently related to underreporting, though the magnitude of these associations varied across drug outcomes. For overall drug overdose deaths, the coefficient for percent pending was –16.8 (robust standard error [SE] = 0.3), meaning that for every 1 percentage point increase in the percentage of death records with manner of death pending investigation, provisional drug overdose deaths were underreported by 16.8%. Associations were similar for deaths involving heroin (β = –17.1, robust SE = 0.4), and somewhat larger for deaths involving any opioid (β = –18.0, robust SE = 0.3), natural and semisynthetic opioids (β = –20.4, robust SE = 0.5), methadone (β = –21.2, robust SE = 0.5), synthetic opioids excluding methadone, (β = –19.0, robust SE = 0.5), and psychostimulants with abuse potential (β = –19.2, robust SE = 0.5). For deaths involving cocaine, the percentage of records pending investigation was not associated with underreporting to the same extent as the other drugs or drug classes (β = –2.9, robust SE = 0.6).

Coefficients from these models were used to generate multiplication factors for the provisional counts of each of the drug outcomes, to adjust for underreporting due to temporal factors (i.e., month ending) and the percentage of records that are reported pending investigation. The percentage of records pending investigation is highest in the most recent months (Figure 4) and ranged from 0.00% to 1.57% across reporting jurisdictions for the 12-month period ending in September 2017 (data not shown).

Figure 3. Average completeness of provisional counts of drug overdose deaths relative to final counts after a 6-month lag, by 12-month ending period: United States, 2015–2016

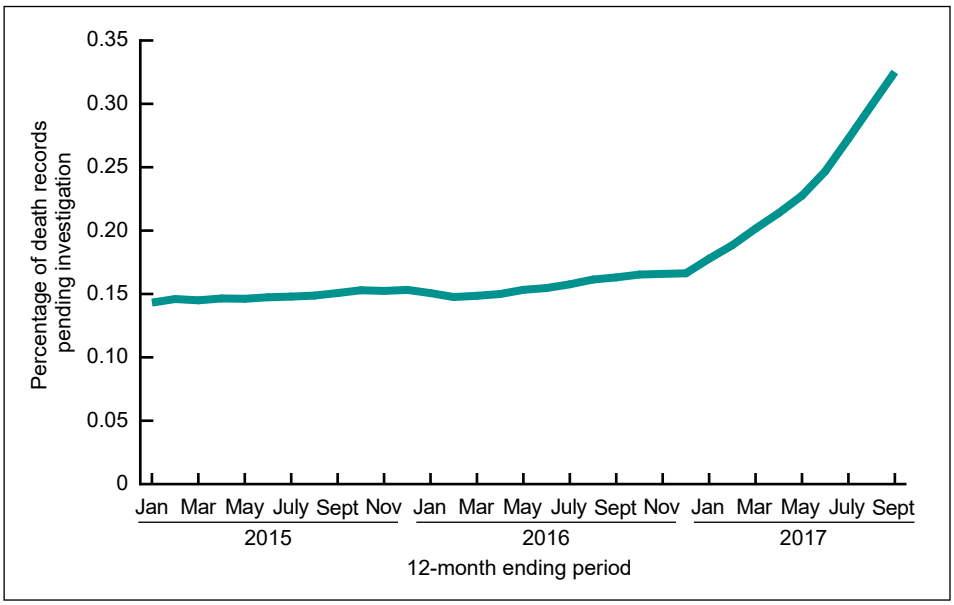


NOTE: Completeness of weekly provisional data is shown with a 6-month lag following the 12-month period ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, February 28, 2016, through July 4, 2017.

Reported and predicted provisional counts of drug overdose deaths

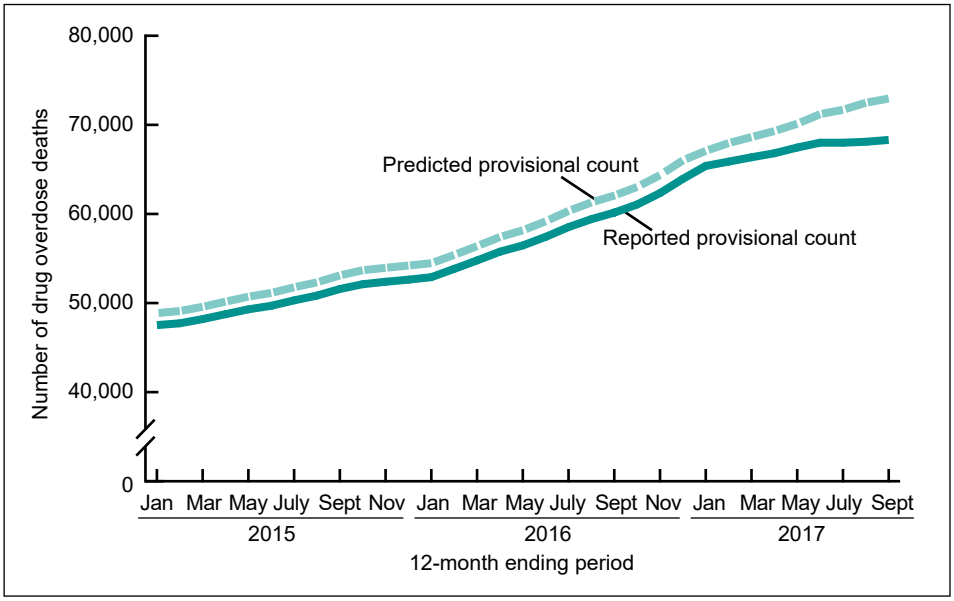
Figure 5 shows the reported provisional counts of drug overdose deaths from January 2015 through September 2017, along with the predicted estimates (dashed line). Figures 6–12 show the reported and predicted provisional counts of deaths involving each of the specific drugs or drug classes over the same time period. The differences between the reported and predicted counts are largest for the most recent time periods,

Figure 4. Percentage of death records with manner of death reported as "pending investigation," by 12-month ending period: United States, 2015–2017



NOTE: Counts are for the 12-month periods ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

Figure 5. Predicted and reported provisional counts of drug overdose deaths, by 12-month ending period: United States, 2015–2017



NOTE: Counts are for the 12-month periods ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

consistent with the larger percentage of records with manner of death pending investigation in more recent months.

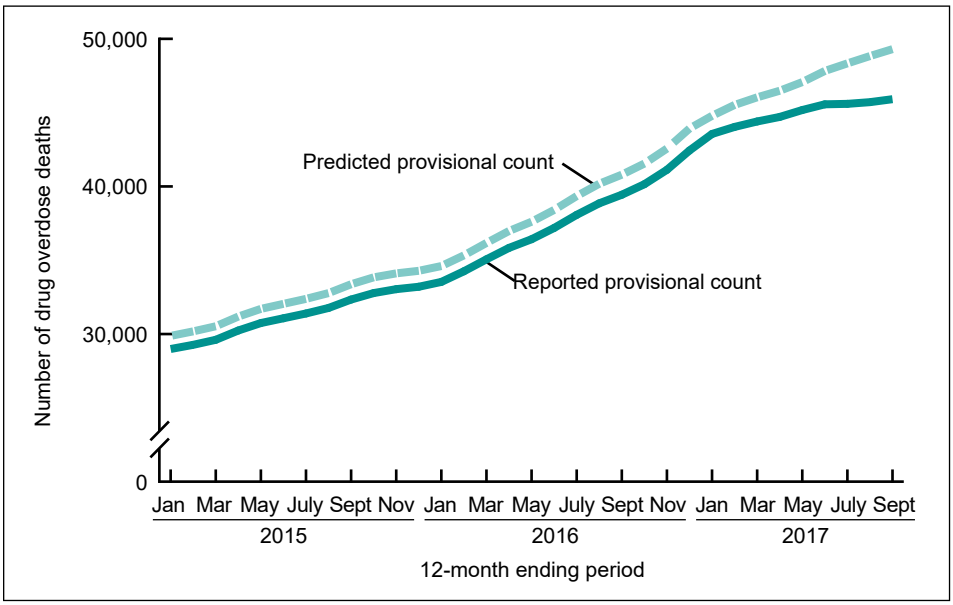
The evaluation of the adjustment methods suggested that the predicted provisional counts for the 12-month period ending with January 2017 after a 6-month lag were generally very close to the observed counts after a 15-month lag, when data should be nearly complete (Table 4). For the United States and 29 jurisdictions, the predicted provisional counts of drug overdose deaths with a 6-month lag were within 2% of the updated values after a 15-month lag. For two jurisdictions (Connecticut and the District of Columbia), the predicted estimates were more than 5% lower than the updated observed counts of drug overdose deaths, suggesting that the adjustment did not fully account for delayed reporting in those jurisdictions. For six jurisdictions (Arizona, Hawaii, Massachusetts, New Jersey, New York [excluding New York City], and Utah), the predicted provisional counts were more than 5% higher than the updated observed counts; however, these jurisdictions reported a high percentage of records pending investigation in the provisional data even after a 15-month lag, suggesting that drug overdose deaths were likely underreported in those jurisdictions even with the 15-month lag.

Discussion

Twelve-month ending counts of provisional drug overdose deaths with a 6-month lag are incomplete relative to final data. The degree of completeness for the total United States varies by month of the year (93% to 98%), with provisional counts for the 12-month ending periods ending in July or August less complete than during other periods of the year. Additionally, completeness varied by jurisdiction of occurrence. For example, for the 12-month ending periods ending in July, completeness of provisional counts was lowest in New York (excluding New York City), New Mexico, and Mississippi (77%, 78%, and 80%, respectively). In contrast, provisional counts were within 1% of final counts (more than 99% complete) for Oklahoma, Virginia, Minnesota, Maine, and Alaska.

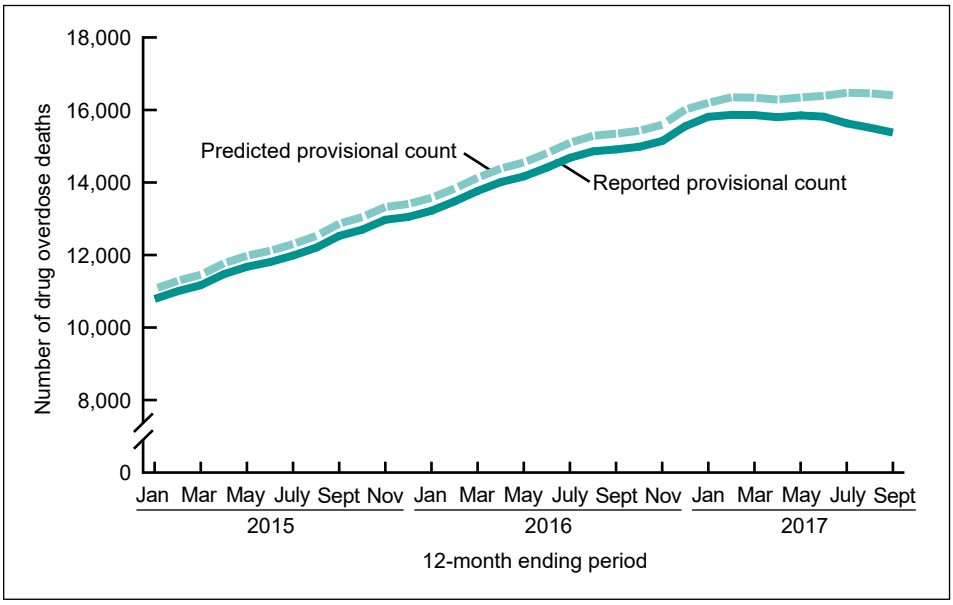
Of most importance for the interpretation of recent trends, results of this analysis suggest that for every 1 percentage point increase in the percentage of death records with manner of death specified as pending investigation, the provisional numbers of drug overdose deaths after a 6-month lag are nearly 17% lower than the final numbers. For specific drugs or drug classes, the degree of underreporting varied from 17% to 21%, with the exception of cocaine (3%). On average, the percentage of death

Figure 6. Predicted and reported provisional counts of drug overdose deaths involving any opioid, by 12-month ending period: United States, 2015–2017



NOTE: Counts are for the 12-month periods ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

Figure 7. Predicted and reported provisional counts of drug overdose deaths involving heroin, by 12-month ending period: United States, 2015–2017



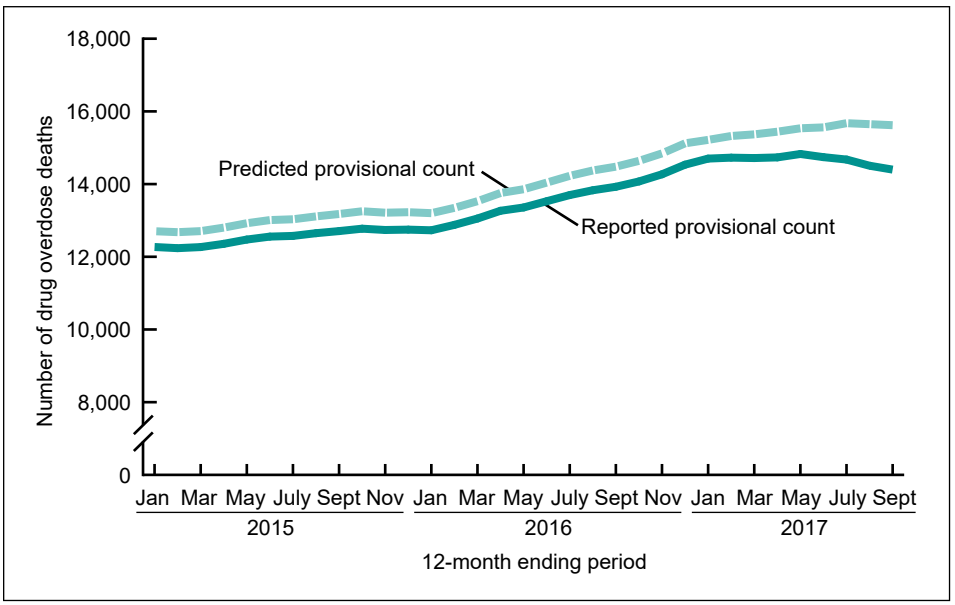
NOTE: Counts are for the 12-month periods ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

records with manner of death pending investigation in provisional data for 2017 ranged from 0.18% to 0.33% for the United States, and was higher for the most recent months. As a result, the provisional numbers of drug overdose deaths will tend to be underestimated to a larger extent in more recent months, potentially showing evidence of declining trends when decreasing numbers of deaths may be due to delayed reporting or incomplete data.

Methods to adjust provisional data for underreporting led to improvements in the accuracy of the provisional data. Predicted provisional counts after a 6-month lag were generally very close to updated provisional counts (within 2%) after a 15-month lag, when data should be nearly complete. For most jurisdictions (29 and the United States), predicted estimates after a 6-month lag were within 2% of updated provisional counts after a 15-month lag. For 25 jurisdictions and the United States, the predicted provisional counts were slightly higher than the updated observed provisional counts after a 15-month lag, though the magnitudes of the differences were generally small (less than 5% in most cases). For 28 jurisdictions, the predicted provisional estimates were slightly lower than the updated observed provisional counts, suggesting that the adjustment methods did not fully account for delayed reporting. Analyses presented here will need to be updated once final historical 2017 data are available, to determine if these differences between predicted and reported counts are consistent throughout the year.

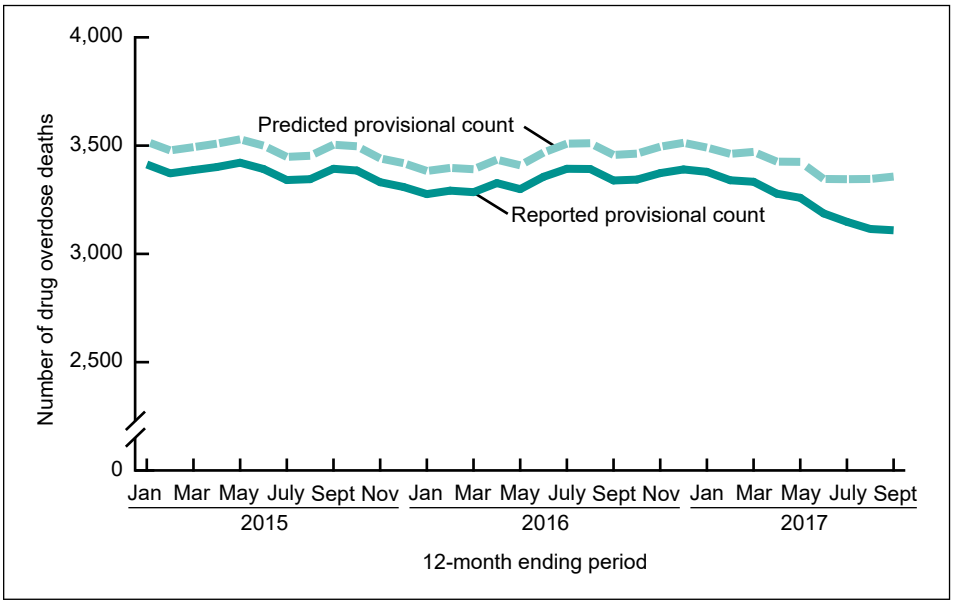
Delayed reporting of provisional drug overdose death data can lead to downward bias in the slope of recent trends. Specifically, the degree of underreporting is largest in the most recent time periods, and trends may therefore appear to be plateauing, or even declining, after periods of historic increases. While data quality metrics related to underreporting, such as the percent completeness and percent pending, are provided in the "Provisional Drug Overdose Death Counts" data visualization (5), the impact of these factors on the magnitude of underreporting and the direction of recent trends is unclear. The provision of predicted provisional counts, adjusted for underreporting, provides a more accurate visual representation of recent trends in drug overdose mortality, and generally suggests that the 12-month ending number of drug overdose deaths occurring in the United States continues to increase in recent months. Given the importance of monitoring trends and geographic variation in drug overdose mortality across the United States, methods to account for underreporting of provisional drug

Figure 8. Predicted and reported provisional counts of drug overdose deaths involving natural and semisynthetic opioids, by 12-month ending period: United States, 2015–2017



NOTE: Counts are for the 12-month periods ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

Figure 9. Predicted and reported provisional counts of drug overdose deaths involving methadone, by 12-month ending period: United States, 2015–2017

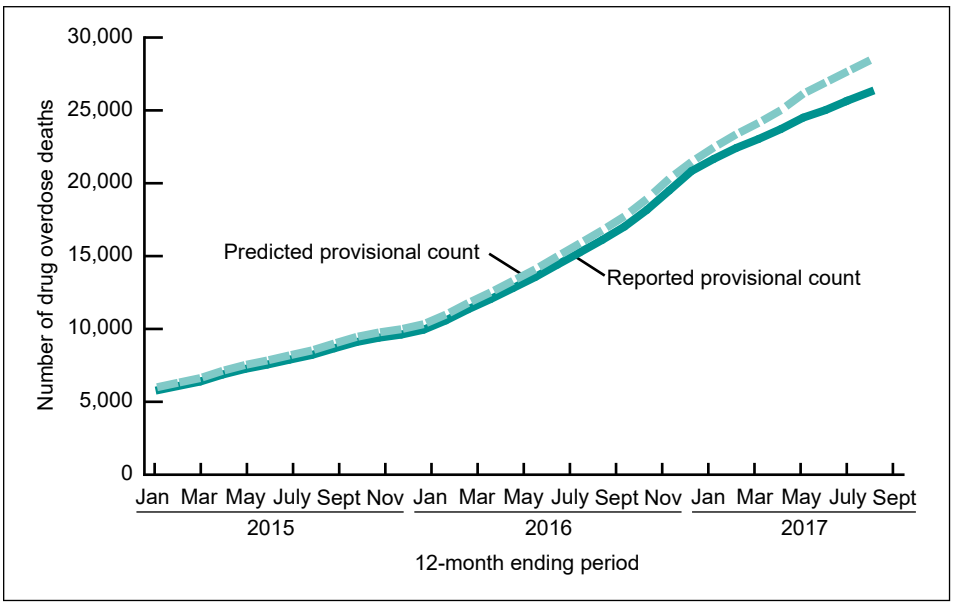


NOTE: Counts are for the 12-month periods ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

overdose mortality data can improve surveillance of these outcomes.

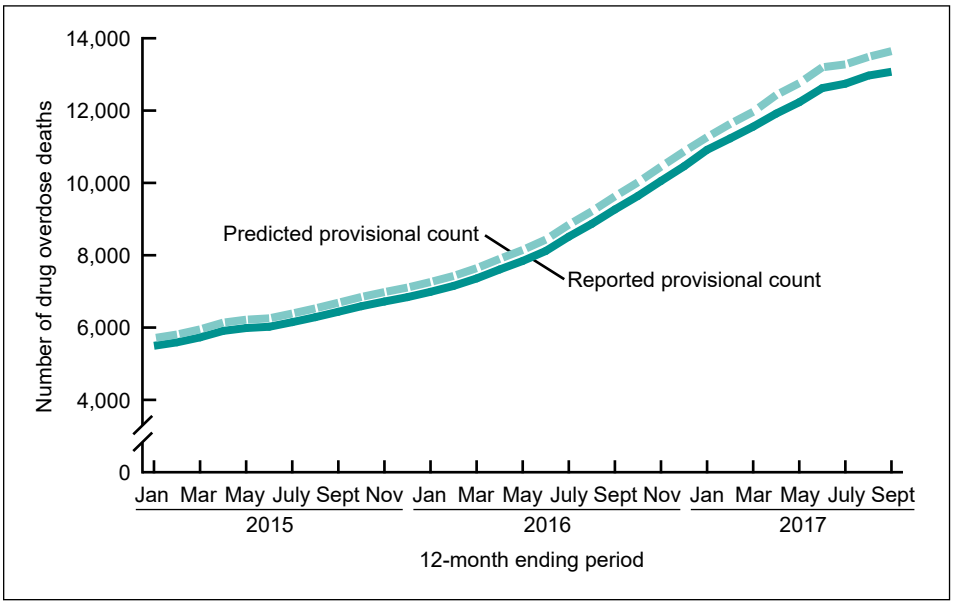
There are some limitations to the approach described in this report. The models from which the multiplication factors are derived will have to be updated each year as timeliness of reporting of drug overdose mortality changes. Rapid improvements or declines in reporting could contribute to greater differences between the predicted provisional counts and the counts based on final data. Final data were used to determine the magnitude of underreporting or delayed reporting in provisional data after a 6-month lag; however, since a certain percentage of records remain pending investigation in the final data, the degree of underreporting in provisional data may be underestimated relative to the true number of drug overdose deaths. While there is variation across jurisdictions in reporting and the percentage of records pending investigation, the adjustment factors were not jurisdiction specific, beyond accounting for a given jurisdiction's percentage of records pending investigation. Fixed effects for jurisdiction were not included in the models, as underreporting for a given jurisdiction may be inconsistent over time and unpredictable. Periodic delays in reporting may be due to one-time factors (i.e., IT system issues), making jurisdiction-specific adjustment factors unreliable. Some jurisdictions may have a relatively low percentage of records pending investigation but still underreport drug overdose deaths. For these jurisdictions, other factors like overall data completeness, the percentage of records with unknown cause of death (R99), or the percentage of drug overdose deaths with a specific drug identified on the death certificate (i.e., drug specificity) could be related to underreporting. For example, some jurisdictions do not submit death certificate information until the cause and manner of death have been determined, and thus these jurisdictions have low percentages of records where the manner of death is indicated as pending investigation. In other cases, the manner of death checkbox may be blank, but terms such as "undetermined" or "pending" might appear in the literal text fields on the death certificate. The methods used in this report do not account for these scenarios, which may also contribute to underreporting. Finally, other analytic methods or approaches are available to address underreporting, such as forecasting or imputation. More sophisticated algorithms or approaches (17–19) may result in predicted estimates that more closely match final data, but they would likely be more difficult to implement in the current NVSS environment for the production of monthly provisional data releases. Additional work is needed to determine whether the

Figure 10. Predicted and reported provisional counts of drug overdose deaths involving synthetic opioids (excluding methadone), by 12-month ending period: United States, 2015–2017



NOTE: Counts are for the 12-month periods ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

Figure 11. Predicted and reported provisional counts of drug overdose deaths involving cocaine, by 12-month ending period: United States, 2015–2017



NOTE: Counts are for the 12-month periods ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

methods described here to account for underreporting in provisional mortality data could be improved in the future.

Conclusions

Provisional drug overdose mortality data can provide timely information about the burden of drug overdose mortality across the United States and where drug overdose mortality is increasing more rapidly. However, provisional counts may understate recent trends, primarily due to delays in the reporting of the cause and manner of death in provisional data. As such, the reported provisional counts represent lower bound estimates of drug overdose mortality. Predicted provisional counts, adjusted for the percentage of death records with manner of death reported as pending investigation, may represent a more accurate picture of recent trends. Nonetheless, predicted provisional counts may not fully account for reporting delays. As such, predicted provisional counts may still underestimate the number of drug overdose deaths occurring in recent months in some jurisdictions, and they cannot be interpreted as an upper bound estimate. It is important to note that flat or declining numbers of drug overdose deaths (either reported or predicted) could be due to incomplete data, true decreases in the number of deaths, or a combination of the two. True declines or plateaus in the numbers of drug overdose deaths across the United States cannot be determined until final data become available approximately 11 months after the data year. Improving the timeliness of full reporting of cause of death would allow for the monitoring of more recent trends with a much shorter lag time. Given the importance of monitoring trends and geographic variation in drug overdose mortality across the United States, provisional drug overdose death data can highlight where drug overdose mortality is increasing more rapidly and inform public health efforts to reduce drug overdose deaths.

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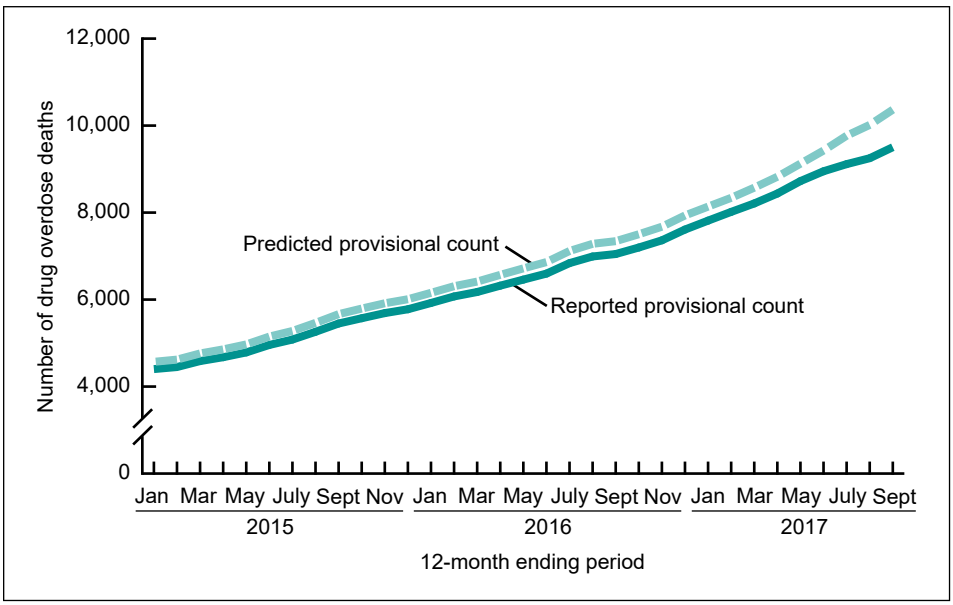
Figure 12. Predicted and reported provisional counts of drug overdose deaths involving psychostimulants with abuse potential, by 12-month ending period: United States, 2015–2017



NOTE: Counts are for the 12-month periods ending in the month indicated.
SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

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List of Detailed Tables

Report tables

Table 1. Completeness of 12-month ending provisional counts of drug overdose deaths relative to final counts, by reporting jurisdiction and ending month

Reporting jurisdiction	January	February	March	April	May	June	July	August	September	October	November	December
United States	97.7	96.8	96.0	96.1	95.5	94.4	93.3	93.9	94.6	95.6	97.0	97.6
Alabama	98.0	97.4	96.9	95.9	95.0	93.8	96.7	96.1	97.4	98.0	98.8	98.5
Alaska	99.4	99.2	99.2	99.8	100.0	100.0	100.0	99.7	100.0	99.8	100.0	100.0
Arizona	98.6	97.8	96.7	95.6	94.6	94.4	95.5	97.6	98.4	98.9	99.1	99.0
Arkansas	93.2	89.6	84.8	79.3	90.2	91.2	87.1	84.3	87.9	95.3	99.8	100.0
California	93.3	89.3	83.8	91.4	90.7	88.7	86.7	87.9	90.0	89.9	91.2	96.9
Colorado	97.5	97.1	94.4	98.3	99.8	97.5	97.8	99.8	99.8	99.1	99.8	99.9
Connecticut	97.1	95.2	94.4	95.0	89.9	87.0	83.7	84.5	87.9	89.5	94.7	98.4
Delaware	99.0	99.3	99.3	99.5	98.8	98.9	96.5	98.1	99.5	100.0	100.0	100.0
District of Columbia	96.0	94.3	94.9	97.4	92.9	88.0	85.9	89.8	92.1	94.3	95.3	98.1
Florida	98.8	97.7	96.7	97.3	97.7	98.3	98.9	99.0	98.6	98.7	99.3	99.8
Georgia	99.1	98.4	97.4	97.4	95.8	93.4	91.7	94.0	95.7	97.3	98.9	99.9
Hawaii	100.0	99.4	99.5	98.5	98.4	98.4	98.0	95.4	98.2	98.8	99.2	99.9
Idaho	99.4	98.1	98.3	99.0	98.7	98.4	97.9	98.5	99.2	98.4	99.6	99.9
Illinois	99.6	99.0	98.6	98.5	97.9	97.4	98.9	99.3	99.7	99.9	99.9	100.0
Indiana	98.2	97.6	98.1	98.3	98.3	97.7	97.1	96.3	96.3	96.7	97.7	99.1
Iowa	99.5	99.0	99.0	99.1	99.4	98.7	98.2	98.7	98.2	96.3	98.4	99.7
Kansas	98.8	97.6	96.6	96.2	95.1	92.9	91.7	94.7	96.1	99.5	100.0	99.9
Kentucky	100.0	99.8	99.7	99.3	98.8	98.0	97.3	98.0	98.9	99.0	99.7	100.0
Louisiana	98.9	98.7	98.9	99.2	99.0	98.3	98.8	99.5	99.6	99.6	99.6	99.3
Maine	99.7	99.6	99.9	100.0	100.0	100.0	99.6	99.7	99.3	98.3	98.1	100.0
Maryland	99.3	99.3	99.5	99.5	99.0	97.2	96.5	97.2	98.7	96.4	98.5	100.0
Massachusetts	98.3	98.8	97.9	98.1	97.2	95.2	96.5	91.1	78.7	83.2	84.7	76.8
Michigan	89.1	92.5	90.5	97.2	95.8	94.1	91.1	88.0	88.1	94.9	95.6	92.3
Minnesota	99.4	99.0	99.6	99.7	99.8	99.8	99.6	99.8	99.7	99.2	99.5	100.0
Mississippi	95.1	90.8	86.3	84.1	80.7	82.7	79.7	81.1	87.1	90.1	92.2	94.9
Missouri	99.7	99.0	98.8	99.1	98.7	97.3	96.1	96.7	97.8	98.7	99.6	100.0
Montana	97.0	97.5	94.6	92.3	92.0	91.2	87.7	89.7	91.5	94.3	96.9	97.5
Nebraska	100.0	99.0	98.9	98.4	98.4	98.3	96.4	99.3	99.5	99.2	99.6	99.9
Nevada	100.0	99.9	98.6	99.2	98.1	97.9	97.3	97.6	99.3	99.5	99.8	100.0
New Hampshire	99.6	98.4	97.7	96.7	93.5	92.8	90.0	96.1	97.9	99.1	99.5	99.9
New Jersey	94.6	92.5	91.2	88.8	89.0	89.4	89.3	89.8	86.7	88.3	91.9	93.2
New Mexico	97.0	93.0	90.7	91.2	87.5	81.6	78.3	88.2	91.8	93.3	95.4	99.3
New York[1]	92.0	86.0	82.3	86.5	85.9	83.3	77.0	76.6	72.4	73.1	75.3	70.3
New York City	98.1	96.6	97.0	96.7	97.5	97.2	98.2	98.1	96.8	99.0	99.7	99.7
North Carolina	95.1	93.7	92.4	92.0	89.2	87.8	86.6	86.1	84.8	85.7	89.5	94.4
North Dakota	100.0	100.0	100.0	94.2	100.0	100.0	98.5	91.2	93.1	99.3	100.0	100.0
Ohio	99.5	99.1	98.5	98.8	98.5	98.2	98.9	99.0	99.2	99.5	99.7	99.9
Oklahoma	97.3	97.5	98.3	99.8	99.6	99.7	99.5	97.7	97.7	97.8	98.6	97.9
Oregon	99.1	98.5	97.9	97.3	94.9	91.8	88.8	91.2	95.1	97.1	99.5	100.0
Pennsylvania	93.1	94.3	95.1	94.1	91.7	87.6	84.6	82.3	82.5	81.3	82.7	83.3

See footnotes at end of table.

Table 1. Completeness of 12-month ending provisional counts of drug overdose deaths relative to final counts, by reporting jurisdiction and ending month—Con.

Reporting jurisdiction	January	February	March	April	May	June	July	August	September	October	November	December
Rhode Island	96.8	98.1	96.1	96.5	95.0	91.7	90.2	94.4	96.7	97.5	99.3	100.0
South Carolina	98.1	97.4	98.8	99.8	98.7	94.6	93.2	92.3	94.3	94.4	96.9	99.8
South Dakota	98.4	98.5	98.5	98.6	98.6	98.5	94.9	90.8	97.0	99.0	99.3	99.8
Tennessee	89.7	87.0	83.5	79.2	79.3	84.4	81.1	79.2	83.3	83.9	87.4	92.3
Texas	98.7	97.9	98.5	98.8	98.7	98.1	98.8	99.4	99.3	99.2	99.3	99.4
Utah	97.8	96.6	95.0	93.7	92.1	88.4	86.8	88.4	89.0	92.6	96.1	98.9
Vermont	100.0	99.5	99.2	99.4	99.0	97.2	98.5	96.2	91.7	91.6	98.4	100.0
Virginia	98.1	95.3	96.7	97.5	97.5	97.3	99.6	99.5	99.1	99.1	99.3	99.3
Washington	99.5	99.2	98.9	98.6	98.2	97.8	98.8	99.4	99.7	99.7	99.8	99.9
West Virginia	99.4	98.9	98.9	98.9	97.3	93.9	91.3	95.5	97.6	97.7	99.5	99.9
Wisconsin	97.9	96.7	97.0	96.9	95.7	94.1	96.1	98.4	98.4	99.2	99.4	99.9
Wyoming	100.0	100.0	100.0	100.0	100.0	97.4	96.0	99.4	100.0	100.0	100.0	100.0

[1]Excludes New York City.

NOTE: Completeness of weekly provisional data is shown with a 6-month lag following the 12-month period ending in the month indicated.

SOURCE: NCHS, National Vital Statistics System, February 28, 2016, through July 4, 2017.

Table 2. Model results of the completeness of provisional data for drug overdose deaths and drug overdose deaths involving any opioid, by month ending and percentage pending

Model parameter	Outcome	
	Drug overdose death	Drug overdose deaths involving any opioid
Intercept	100.5 (0.1)	100.5 (0.1)
February	–0.4 (0.1)	–0.3 (0.1)
March	–0.4 (0.2)	–0.4 (0.2)
April	–0.5 (0.2)	–0.4 (0.2)
May	–0.5 (0.2)	–0.4 (0.2)
June	–0.8 (0.2)	–0.7 (0.2)
July	–1.0 (0.2)	–1.2 (0.2)
August	–1.5 (0.2)	–1.5 (0.2)
September	–1.4 (0.2)	–1.5 (0.2)
October	–1.2 (0.1)	–1.2 (0.2)
November	–0.9 (0.1)	–1.0 (0.2)
December	–0.2 (0.1)	–0.2 (0.2)
Percentage pending	–16.8 (0.3)	–18.0 (0.3)

NOTES: Values are estimated coefficients (robust standard errors). Drug overdose deaths were identified using underlying cause-of-death codes from the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* (ICD–10): X40–X44 (unintentional drug overdose), X60–X64 (suicide by drug overdose), X85 (homicide by drug poisoning), and Y10–Y14 (drug poisoning of undetermined intent). Any opioid is defined using ICD–10 multiple-cause-of-death codes T40.0–T40.4 or T40.6.

SOURCE: NCHS, National Vital Statistics System, February 28, 2016, through July 4, 2017.

Table 3. Model results of the completeness of provisional data for deaths involving specific drugs and drug classes, by month ending and percentage pending

Model parameter	Outcome					
	Heroin	Natural and semisynthetic opioids	Methadone	Synthetic opioids, excluding methadone	Cocaine	Psychostimulants with abuse potential
Intercept	100.7 (0.2)	100.2 (0.2)	100.6 (0.2)	100.5 (0.2)	97.4 (0.3)	99.5 (0.4)
February	–0.4 (0.1)	–0.3 (0.2)	–0.1 (0.2)	–0.4 (0.2)	–0.3 (0.2)	0.3 (0.2)
March	–0.2 (0.2)	–0.4 (0.2)	–0.3 (0.3)	–0.6 (0.3)	–0.3 (0.4)	0.2 (0.3)
April	0.0 (0.2)	–0.5 (0.2)	–0.3 (0.3)	–1.0 (0.3)	–0.9 (0.5)	0.3 (0.4)
May	0.2 (0.2)	–0.2 (0.3)	–0.6 (0.3)	–1.3 (0.3)	–0.9 (0.5)	0.5 (0.4)
June	0.0 (0.3)	–0.5 (0.3)	–0.1 (0.3)	–2.0 (0.3)	–1.1 (0.5)	0.2 (0.4)
July	–1.1 (0.3)	–1.1 (0.3)	–0.7 (0.3)	–2.3 (0.3)	–0.6 (0.4)	–0.9 (0.5)
August	–1.3 (0.2)	–1.5 (0.2)	–1.1 (0.3)	–2.0 (0.3)	–0.4 (0.4)	–1.4 (0.4)
September	–1.4 (0.2)	–1.4 (0.2)	–1.1 (0.3)	–1.9 (0.2)	–0.7 (0.3)	–1.5 (0.4)
October	–1.2 (0.2)	–1.1 (0.2)	–0.7 (0.2)	–1.5 (0.2)	–0.9 (0.3)	–0.8 (0.4)
November	–1.0 (0.2)	–0.8 (0.2)	–0.6 (0.2)	–1.1 (0.2)	–1.1 (0.2)	–0.1 (0.4)
December	–0.4 (0.2)	0.1 (0.2)	0.2 (0.2)	–0.3 (0.2)	–0.7 (0.1)	0.7 (0.5)
Percentage pending	–17.1 (0.4)	–20.4 (0.5)	–21.2 (0.5)	–19.0 (0.5)	–2.9 (0.6)	–19.2 (0.5)

NOTES: Values are estimated coefficients (robust standard errors). Specific drugs or drug classes are defined using the following *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* multiple-cause-of-death codes: heroin, T40.1; natural and semisynthetic opioids, T40.2; methadone, T40.3; synthetic opioids, excluding methadone, T40.4; cocaine, T40.5; and psychostimulants with abuse potential, T43.6.

SOURCE: NCHS, National Vital Statistics System, February 28, 2016, through July 4, 2017.

Table 4. Reported and predicted provisional counts of drug overdose deaths for the 12-month period ending with January 2017, by reporting jurisdiction

Reporting jurisdiction	6-month lag		15-month lag	Percent difference between predicted (6-month lag) and reported (15-month lag) count	Percent of records pending investigation (6-month lag)
	Reported provisional count	Predicted provisional count	Reported provisional count		
United States	63,295	66,158	65,392	–1.2	0.2
Alabama	740	780	762	–2.4	0.3
Alaska	126	128	126	–1.6	0.1
Arizona	1,399	1,587	1,417	–12.0	0.6
Arkansas	373	377	384	1.8	0.1
California	4,571	4,972	4,767	–4.3	0.4
Colorado	973	977	976	–0.1	0.0
Connecticut	908	935	985	5.1	0.0
Delaware	306	306	310	1.3	0.0
District of Columbia	300	303	325	6.8	0.0
Florida	5,150	5,193	5,180	–0.3	0.0
Georgia	1,330	1,352	1,399	3.4	0.1
Hawaii	199	216	203	–6.4	0.3
Idaho	223	226	226	0.0	0.1
Illinois	2,518	2,520	2,524	0.2	0.0
Indiana	1,548	1,550	1,576	1.6	0.0
Iowa	322	321	325	1.2	0.0
Kansas	318	324	326	0.6	0.1
Kentucky	1,460	1,457	1,480	1.6	0.0
Louisiana	1,013	1,011	1,016	0.5	0.0
Maine	355	360	368	2.2	0.0
Maryland	2,151	2,183	2,174	–0.4	0.0
Massachusetts	2,203	2,426	2,223	–9.1	0.5
Michigan	2,291	2,419	2,310	–4.7	0.3
Minnesota	647	644	655	1.7	0.0
Mississippi	307	313	326	4.0	0.1
Missouri	1,362	1,361	1,393	2.3	0.0
Montana	117	121	119	–1.7	0.1
Nebraska	110	111	114	2.6	0.0
Nevada	699	696	705	1.3	0.0
New Hampshire	451	461	458	–0.7	0.1
New Jersey	1,997	2,197	2,080	–5.6	0.4
New Mexico	471	494	502	1.6	0.1
New York[1]	2,111	2,447	2,283	–7.2	0.6
New York City	1,476	1,488	1,479	–0.6	0.1
North Carolina	1,779	1,959	1,968	0.5	0.3
North Dakota	80	84	81	–3.7	0.3
Ohio	4,072	4,656	4,501	–3.4	0.0
Oklahoma	802	803	830	3.3	0.0
Oregon	478	491	504	2.6	0.1
Pennsylvania	4,602	4,929	4,855	–1.5	0.3
Rhode Island	334	349	350	0.3	0.1
South Carolina	881	898	903	0.6	0.0
South Dakota	73	73	75	2.7	0.0
Tennessee	1,562	1,656	1,644	–0.7	0.2
Texas	2,804	2,883	2,809	–2.6	0.2
Utah	615	764	640	–19.4	0.9
Vermont	135	135	137	1.5	0.0
Virginia	1,391	1,390	1,392	0.1	0.0
Washington	1,100	1,105	1,104	–0.1	0.0
West Virginia	881	922	911	–1.2	0.2
Wisconsin	1,092	1,116	1,101	–1.4	0.1
Wyoming	89	89	91	2.2	0.0

[1]Excludes New York City.

SOURCE: NCHS, National Vital Statistics System, July 2, 2017, and April 15, 2018.

Technical Notes

Definitions

12-month ending period refers to the 12-month periods ending with the month specified, and are the time periods used for reporting provisional drug overdose deaths. For example, data for the 12-month period ending with September 2017 include deaths that occurred from October 1, 2016, through September 30, 2017.

Completeness is the percentage of drug overdose death records available in weekly provisional data as compared with final data. Because drug overdose deaths often require lengthy investigations, including toxicological analysis, death certificates may be initially filed with a manner of death "pending investigation" or with a preliminary or unknown cause of death. Provisional counts of drug overdose deaths therefore tend to be lower than the final count.

Lag time is the time between when the death occurred and when the death certificate data is available in the provisional data snapshots. This length of time varies due to the time it takes for jurisdictions to submit data, and for the data to be processed and coded by the National Center for Health Statistics (NCHS).

Multiplication factor is an adjustment or weight that can be applied to provisional counts to adjust for delayed reporting.

Provisional count is the number of deaths available in the surveillance data as of a given date.

Nature and source of data

Provisional mortality data—Weekly snapshots

In late 2014, NCHS began taking weekly snapshots of its mortality data, which include death certificate records from the 50 states, New York City, and the District of Columbia. Multiple-cause-of-death codes were first added to the surveillance database on February 28, 2016, enabling the analysis of specific drugs and drug categories in addition to overall drug overdose mortality. Weekly provisional mortality data captured from February 28, 2016, through July 4, 2017 (approximately 6 months after the full 2016 data year) were used to calculate the number of drug overdose death records available for analysis in the National Vital Statistics System surveillance database.

Cause-of-death classification

Mortality statistics are compiled in accordance with World Health Organization (WHO) regulations specifying that WHO member countries classify and code causes of death in accordance with the current revision of the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* (ICD–10). ICD provides the basic guidance used in virtually all countries to code and classify causes of death. It provides not only disease, injury, and poisoning categories but also the rules used to select the single underlying cause of death for tabulation from the conditions reported on the death certificate, as well as definitions, tabulation lists, the format of the death certificate, and regulations on use of the classification. Causes of death for data presented in this report were coded according to ICD guidelines described in annual issues of the NCHS Instruction Manuals (20).

Provisional data on cause of death are subject to some nonrandom sampling error. This is because the delay in receiving the report of a death depends on the cause of death. Furthermore, for some deaths, the final cause may not be available at the time that the death was reported. In those cases, the cause of death may be reported as unknown or pending investigation and coded to ICD–10 code R99 (other ill-defined and unspecified causes of mortality). In the final data, some of the deaths with unknown cause will be reassigned to specific causes if further, more specific cause-of-death information is provided.

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