Method to Adjust Provisional Counts of Drug Overdose Deaths for Underreporting

Lag times between when the death occurred and when the data are available for analysis in the NVSS surveillance database are longer for deaths due to drug overdose than for other causes of death such as heart disease [1]. Drug overdose deaths often require lengthy investigations, including toxicological analysis, and death certificates may be initially filed with a manner of death "pending investigation" and/or with a preliminary or unknown cause of death. Because of this, provisional counts of drug overdose deaths are presented with a 6-month lag.

Even with this lag, provisional counts of drug overdose deaths are underestimated relative to final counts. On average, provisional counts of drug overdose deaths were 83% complete after 6 months. The degree of underestimation is primarily a function of the percentage of records with the manner of death reported as "pending investigation" which 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, methods were used to adjust provisional counts to reduce the likelihood that provisional data will be misinterpreted such as showing evidence of declining trends, when observed decreases in provisional numbers of drug overdose deaths may be largely due to delayed reporting or incomplete data on cause and manner of death.

Adjustments for Delayed Reporting

In late 2014, 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 (MCOD) were first added to the surveillance database on February 28th, 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 six 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 [2, 3] were used to compare with provisional data.

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 percent pending are correlated across weekly provisional data sets within reporting jurisdictions, models accounted for this correlation by jurisdiction using a generalized estimating equation (GEE) approach with an exchangeable correlation structure.

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

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

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 8 drug overdose outcomes of interest:

1) Drug overdose deaths,
2) Deaths involving opioids,
3) Deaths involving heroin,
4) Deaths involving natural and semisynthetic opioids,
5) Deaths involving methadone,
6) Deaths involving synthetic opioids excluding methadone,
7) Deaths involving cocaine, and
8) Deaths involving psychostimulants with abuse potential.

Coefficients from these models were used to develop multiplication factors (see below) [4] based on the 12-month ending period and percentage of records "pending investigation," for each of the 8 drug outcomes of interest. Multiplication factors have been used in prior analyses and public health surveillance efforts to adjust for underreporting and under-ascertainment of various infectious disease outcomes, [4, 5, 6, 7, 8, 9] and similar approaches have been used to adjust for reporting delays in the surveillance of cancer incidence. [10, 11, 12] Predicted provisional counts

of each of the drug overdose outcomes were calculated by multiplying the reported provisional counts by the estimated multiplication factors.

$$Multiplication\ Factor_{it} = \frac{1}{\widehat{Y_{it}}}$$, where $\widehat{Y_{it}}$ is expressed as a proportion.

$$Adjusted\ Count_{it} = \text{Provisional Count}_{it} * Multiplication\ Factor_{it}$$

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 [13], 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.

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 can thus be used to determine how well the predicted provisional counts will match updated or final estimates.

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 93-94% 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 ranged from lows of 77% (New York, excluding New York City), 78% (New Mexico), and 80% (Mississippi) to over 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 2-3). 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 SE: 0.3), meaning that for every one percentage point increase in the percent 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 semi-synthetic 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 ending period ending in September, 2017 (data not shown).

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 (dotted 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, 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 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 6 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.

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 U.S. 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 varies 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 (over 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 one percentage point increase in the percent 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 records with manner of death "pending investigation" in provisional data for 2017 ranged from 0.18% to 0.33% for the US, 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 US, 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 (<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, [13] the impact of these factors on the magnitude of underreporting and the direction of recent trends is opaque. 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 US 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 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 [10, 11, 12] may result in predicted estimates that more closely match final data, but would likely be more difficult to implement in the current NVSS environment for the production of monthly provisional data releases. Further work is needed to determine whether the methods described here to account for underreporting in provisional mortality data could be improved in the future.

Summary

Provisional drug overdose mortality data can provide timely information about the burden of drug overdose mortality across the U.S. 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 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 U.S. cannot be ascertained until final data become available approximately 11 months after the close of the data year. Improving the timeliness of full reporting of cause and manner 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.

References

[1] Spencer M, Ahmad FB. Timeliness of death certificate data for mortality surveillance and provisional estimates. *Vital Statistics Rapid Release Special Report*, No. 001, 2016.

[2] Murphy S, Xu J, Kochanek K, Curtin S, Arias E. Deaths: Final data for 2015. *National Vital Statistics Reports* 2017; 66(6). Hyattsville, MD, National Center for Health Statistics.

[3] Kochanek K, Murphy S, Xu J, Arias E. Mortality in the United States, 2016. *NCHS Data Brief, No. 293*, Hyattsville, MD, National Center for Health Statistics, 2017.

[4] Gibbons C, Mangen M, Plass D, Havelaar A, Brooke R, Kramarz P et al. Measuring underreporting and under-ascertainment in infectious disease datasets: a comparison of methods. *BMC Public Health* 2014;14:147.

[5] Kristensen M, van Lier A, Eilers R, McDonald S, Opstelten W, van der Maas N et al. Burden of four vaccine preventable diseases in older adults. *Vaccine* 2016;34(7):942-949.

[6] Stanaway J, Shepard D, Undurraga E, Halasa Y, Coffeng L, Brady O et al. The global burden of dengue: an analysis from the Global Burden of Disease Study 2013. *Lancet Infect Dis* 2016;16(6):712-723.

[7] Sethi D, Wheeler J, Rodrigues L, Fox S, Roderick P. Investigation of under-ascertainment in epidemiological studies based in general practice. *Int J Epidemiol* 1999;28:106-112.

[8] Van Lier A, McDonald S, Bouwknegt M, Kretzschmar M, Havelaar A, Mangen M et al. Disease Burden of 32 Infectious Diseases in the Netherlands, 2007-2011. *PLoS ONE* 2016;11(4):e0153106.

[9] Undurraga E, Halasa Y, Shepard D. Use of Expansion Factors to Estimate the Burden of Dengue in Southeast Asia: A Systematic Analysis. *PLoS Negl Trop Dis* 2013;7(2):e2056.

[10] Altekruse S, Kosary C, Krapcho M, Neyman N, Aminou R, Waldron W et al., Technical notes - Reporting Delay. *SEER Cancer Statistics Review, 1975-2007*, Bethesda, MD, National Cancer Institute. 2010, pp. 12-16.

[11] Midthune D, Fay M, Clegg L, Feuer E, Modeling reporting delays and reporting corrections in cancer registry data. *J Am Stat Assoc* 2005; 100(469):61-70.

[12] Clegg L, Feuer E, Midthune D, Fay M, Hankey B. Impact of reporting delay and reporting error on cancer incidence rates and trends. *J Natl Cancer Inst* 2002;94:1537-45.

[13] Ahmad F, Rossen LM, Spencer MR, Warner M, Sutton P. Provisional drug overdose death counts. National Center for Health Statistics. 2018. Available from: https://www.cdc.gov/nchs/nvss/vsrr/drug-overdose-data.htm.

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Tables

Table 1. Completeness of 12 month-ending provisional counts of drug overdose deaths relative to final counts by reporting jurisdiction and ending month (2015-2016).

Reporting Jurisdiction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
US	97.7	96.8	96.0	96.1	95.5	94.4	93.3	93.9	94.6	95.6	97.0	97.6
AK	99.4	99.2	99.2	99.8	100.0	100.0	100.0	99.7	100.0	99.8	100.0	100.0
AL	98.0	97.4	96.9	95.9	95.0	93.8	96.7	96.1	97.4	98.0	98.8	98.5
AR	93.2	89.6	84.8	79.3	90.2	91.2	87.1	84.3	87.9	95.3	99.8	100.0
AZ	98.6	97.8	96.7	95.6	94.6	94.4	95.5	97.6	98.4	98.9	99.1	99.0
CA	93.3	89.3	83.8	91.4	90.7	88.7	86.7	87.9	90.0	89.9	91.2	96.9
CO	97.5	97.1	94.4	98.3	99.8	97.5	97.8	99.8	99.8	99.1	99.8	99.9
CT	97.1	95.2	94.4	95.0	89.9	87.0	83.7	84.5	87.9	89.5	94.7	98.4
DC	96.0	94.3	94.9	97.4	92.9	88.0	85.9	89.8	92.1	94.3	95.3	98.1
DE	99.0	99.3	99.3	99.5	98.8	98.9	96.5	98.1	99.5	100.0	100.0	100.0
FL	98.8	97.7	96.7	97.3	97.7	98.3	98.9	99.0	98.6	98.7	99.3	99.8
GA	99.1	98.4	97.4	97.4	95.8	93.4	91.7	94.0	95.7	97.3	98.9	99.9
HI	100.0	99.4	99.5	98.5	98.4	98.4	98.0	95.4	98.2	98.8	99.2	99.9
IA	99.5	99.0	99.0	99.1	99.4	98.7	98.2	98.7	98.2	96.3	98.4	99.7
ID	99.4	98.1	98.3	99.0	98.7	98.4	97.9	98.5	99.2	98.4	99.6	99.9
IL	99.6	99.0	98.6	98.5	97.9	97.4	98.9	99.3	99.7	99.9	99.9	100.0
IN	98.2	97.6	98.1	98.3	98.3	97.7	97.1	96.3	96.3	96.7	97.7	99.1
KS	98.8	97.6	96.6	96.2	95.1	92.9	91.7	94.7	96.1	99.5	100.0	99.9
KY	100.0	99.8	99.7	99.3	98.8	98.0	97.3	98.0	98.9	99.0	99.7	100.0
LA	98.9	98.7	98.9	99.2	99.0	98.3	98.8	99.5	99.6	99.6	99.6	99.3
MA	98.3	98.8	97.9	98.1	97.2	95.2	96.5	91.1	78.7	83.2	84.7	76.8
MD	99.3	99.3	99.5	99.5	99.0	97.2	96.5	97.2	98.7	96.4	98.5	100.0
ME	99.7	99.6	99.9	100.0	100.0	100.0	99.6	99.7	99.3	98.3	98.1	100.0
MI	89.1	92.5	90.5	97.2	95.8	94.1	91.1	88.0	88.1	94.9	95.6	92.3
MN	99.4	99.0	99.6	99.7	99.8	99.8	99.6	99.8	99.7	99.2	99.5	100.0
MO	99.7	99.0	98.8	99.1	98.7	97.3	96.1	96.7	97.8	98.7	99.6	100.0

MS	95.1	90.8	86.3	84.1	80.7	82.7	79.7	81.1	87.1	90.1	92.2	94.9
MT	97.0	97.5	94.6	92.3	92.0	91.2	87.7	89.7	91.5	94.3	96.9	97.5
NC	95.1	93.7	92.4	92.0	89.2	87.8	86.6	86.1	84.8	85.7	89.5	94.4
ND	100.0	100.0	100.0	94.2	100.0	100.0	98.5	91.2	93.1	99.3	100.0	100.0
NE	100.0	99.0	98.9	98.4	98.4	98.3	96.4	99.3	99.5	99.2	99.6	99.9
NH	99.6	98.4	97.7	96.7	93.5	92.8	90.0	96.1	97.9	99.1	99.5	99.9
NJ	94.6	92.5	91.2	88.8	89.0	89.4	89.3	89.8	86.7	88.3	91.9	93.2
NM	97.0	93.0	90.7	91.2	87.5	81.6	78.3	88.2	91.8	93.3	95.4	99.3
NV	100.0	99.9	98.6	99.2	98.1	97.9	97.3	97.6	99.3	99.5	99.8	100.0
NY[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
YC	98.1	96.6	97.0	96.7	97.5	97.2	98.2	98.1	96.8	99.0	99.7	99.7
OH	99.5	99.1	98.5	98.8	98.5	98.2	98.9	99.0	99.2	99.5	99.7	99.9
OK	97.3	97.5	98.3	99.8	99.6	99.7	99.5	97.7	97.7	97.8	98.6	97.9
OR	99.1	98.5	97.9	97.3	94.9	91.8	88.8	91.2	95.1	97.1	99.5	100.0
PA	93.1	94.3	95.1	94.1	91.7	87.6	84.6	82.3	82.5	81.3	82.7	83.3
RI	96.8	98.1	96.1	96.5	95.0	91.7	90.2	94.4	96.7	97.5	99.3	100.0
SC	98.1	97.4	98.8	99.8	98.7	94.6	93.2	92.3	94.3	94.4	96.9	99.8
SD	98.4	98.5	98.5	98.6	98.6	98.5	94.9	90.8	97.0	99.0	99.3	99.8
TN	89.7	87.0	83.5	79.2	79.3	84.4	81.1	79.2	83.3	83.9	87.4	92.3
TX	98.7	97.9	98.5	98.8	98.7	98.1	98.8	99.4	99.3	99.2	99.3	99.4
UT	97.8	96.6	95.0	93.7	92.1	88.4	86.8	88.4	89.0	92.6	96.1	98.9
VA	98.1	95.3	96.7	97.5	97.5	97.3	99.6	99.5	99.1	99.1	99.3	99.3
VT	100.0	99.5	99.2	99.4	99.0	97.2	98.5	96.2	91.7	91.6	98.4	100.0
WA	99.5	99.2	98.9	98.6	98.2	97.8	98.8	99.4	99.7	99.7	99.8	99.9
WI	97.9	96.7	97.0	96.9	95.7	94.1	96.1	98.4	98.4	99.2	99.4	99.9
WV	99.4	98.9	98.9	98.9	97.3	93.9	91.3	95.5	97.6	97.7	99.5	99.9
WY	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 (YC)

Table 2. Model results of the completeness of provisional data by month-ending and percent pending: Drug overdose deaths and deaths involving any opioid. Values are estimated coefficients (robust standard errors).

	Outcome	
Model Parameters	**Drug overdose**	**Any Opioids (T40.0-T40.4,T40.6)**
Intercept	100.5 (0.1)	100.5 (0.1)
Feb	-0.4 (0.1)	-0.3 (0.1)
Mar	-0.4 (0.2)	-0.4 (0.2)
Apr	-0.5 (0.2)	-0.4 (0.2)
May	-0.5 (0.2)	-0.4 (0.2)
Jun	-0.8 (0.2)	-0.7 (0.2)
Jul	-1.0 (0.2)	-1.2 (0.2)
Aug	-1.5 (0.2)	-1.5 (0.2)
Sep	-1.4 (0.2)	-1.5 (0.2)
Oct	-1.2 (0.1)	-1.2 (0.2)
Nov	-0.9 (0.1)	-1.0 (0.2)
Dec	-0.2 (0.1)	-0.2 (0.2)
Percent Pending	-16.8 (0.3)	-18.0 (0.3)

Table 3. Model results of the completeness of provisional data by month-ending and percent pending: deaths involving specific drugs and drug classes. Values are estimated coefficients (robust standard errors).

	Outcome					
Model Parameters	**Heroin (T40.1)**	**Natural & semi-synthetic opioids (T40.2)**	**Methadone (T40.3)**	**Synthetic opioids, excl. methadone (T40.4)**	**Cocaine (T40.5)**	**Psychostim. w/ abuse potential (T43.6)**
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)
Feb	-0.4 (0.1)	-0.3 (0.2)	-0.1 (0.2)	-0.4 (0.2)	-0.3 (0.2)	0.3 (0.2)
Mar	-0.2 (0.2)	-0.4 (0.2)	-0.3 (0.3)	-0.6 (0.3)	-0.3 (0.4)	0.2 (0.3)
Apr	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)
Jun	0.0 (0.3)	-0.5 (0.3)	-0.1 (0.3)	-2.0 (0.3)	-1.1 (0.5)	0.2 (0.4)
Jul	-1.1 (0.3)	-1.1 (0.3)	-0.7 (0.3)	-2.3 (0.3)	-0.6 (0.4)	-0.9 (0.5)
Aug	-1.3 (0.2)	-1.5 (0.2)	-1.1 (0.3)	-2.0 (0.3)	-0.4 (0.4)	-1.4 (0.4)
Sep	-1.4 (0.2)	-1.4 (0.2)	-1.1 (0.3)	-1.9 (0.2)	-0.7 (0.3)	-1.5 (0.4)
Oct	-1.2 (0.2)	-1.1 (0.2)	-0.7 (0.2)	-1.5 (0.2)	-0.9 (0.3)	-0.8 (0.4)
Nov	-1.0 (0.2)	-0.8 (0.2)	-0.6 (0.2)	-1.1 (0.2)	-1.1 (0.2)	-0.1 (0.4)
Dec	-0.4 (0.2)	0.1 (0.2)	0.2 (0.2)	-0.3 (0.2)	-0.7 (0.1)	0.7 (0.5)
Percent 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)

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

	6-month lag		15-month lag		
Jurisdiction	**Reported Provisional Count**	**Predicted Provisional Count**	**Reported Provisional Count**	**Percent Difference between Predicted and Reported Count**	**Percent of Records Pending Investigation**
United States	63,295	66,158	65,392	-1.2	0.2
Alaska	126	128	126	-1.6	0.1
Alabama	740	780	762	-2.4	0.3
Arkansas	373	377	384	1.8	0.1
Arizona	1,399	1,587	1,417	-12.0	0.6
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
District of Columbia	300	303	325	6.8	0.0
Delaware	306	306	310	1.3	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
Iowa	322	321	325	1.2	0.0
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
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
Massachusetts	2,203	2,426	2,223	-9.1	0.5
Maryland	2,151	2,183	2,174	-0.4	0.0
Maine	355	360	368	2.2	0.0

Michigan	2,291	2,419	2,310	-4.7	0.3
Minnesota	647	644	655	1.7	0.0
Missouri	1,362	1,361	1,393	2.3	0.0
Mississippi	307	313	326	4.0	0.1
Montana	117	121	119	-1.7	0.1
North Carolina	1,779	1,959	1,968	0.5	0.3
North Dakota	80	84	81	-3.7	0.3
Nebraska	110	111	114	2.6	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
Nevada	699	696	705	1.3	0.0
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
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
Virginia	1,391	1,390	1,392	0.1	0.0
Vermont	135	135	137	1.5	0.0
Washington	1,100	1,105	1,104	-0.1	0.0
Wisconsin	1,092	1,116	1,101	-1.4	0.1
West Virginia	881	922	911	-1.2	0.2
Wyoming	89	89	91	2.2	0.0

[1] Excludes New York City.

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

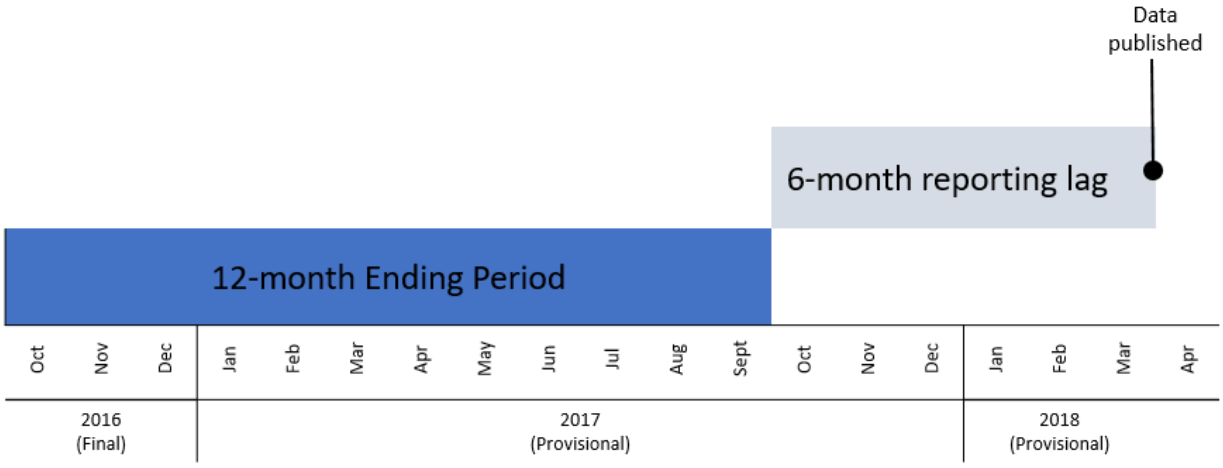


Figure 2. Provisional 12 month-ending data with a 6-month lag and 15-month lag.

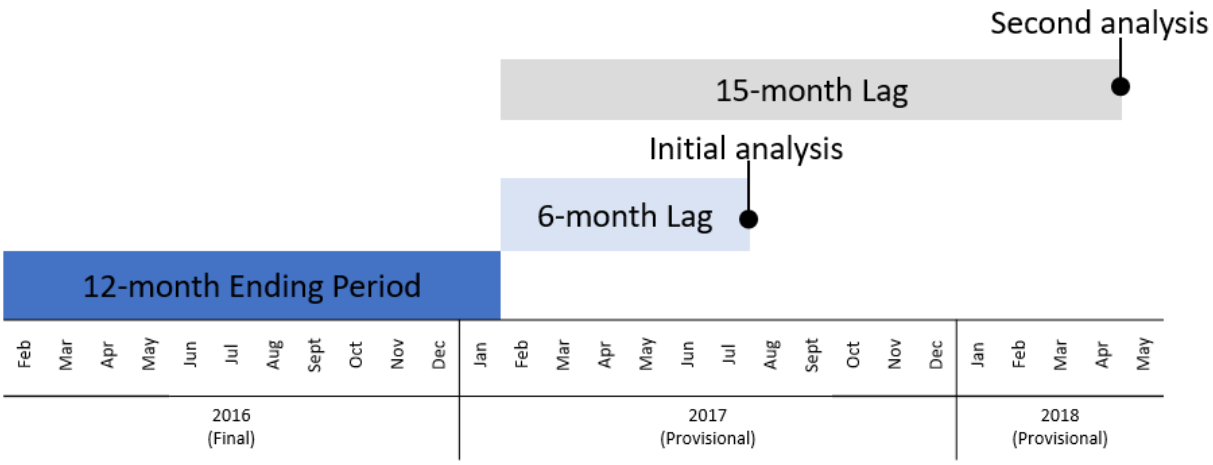
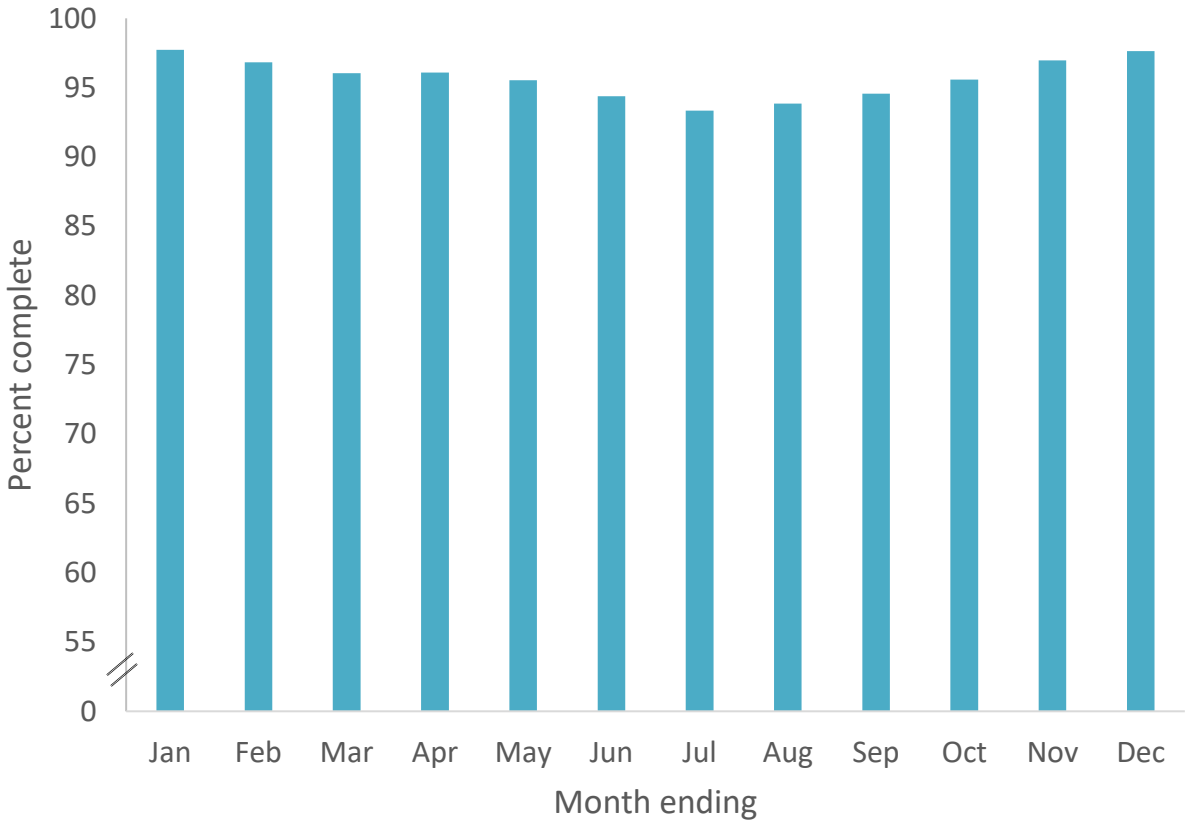


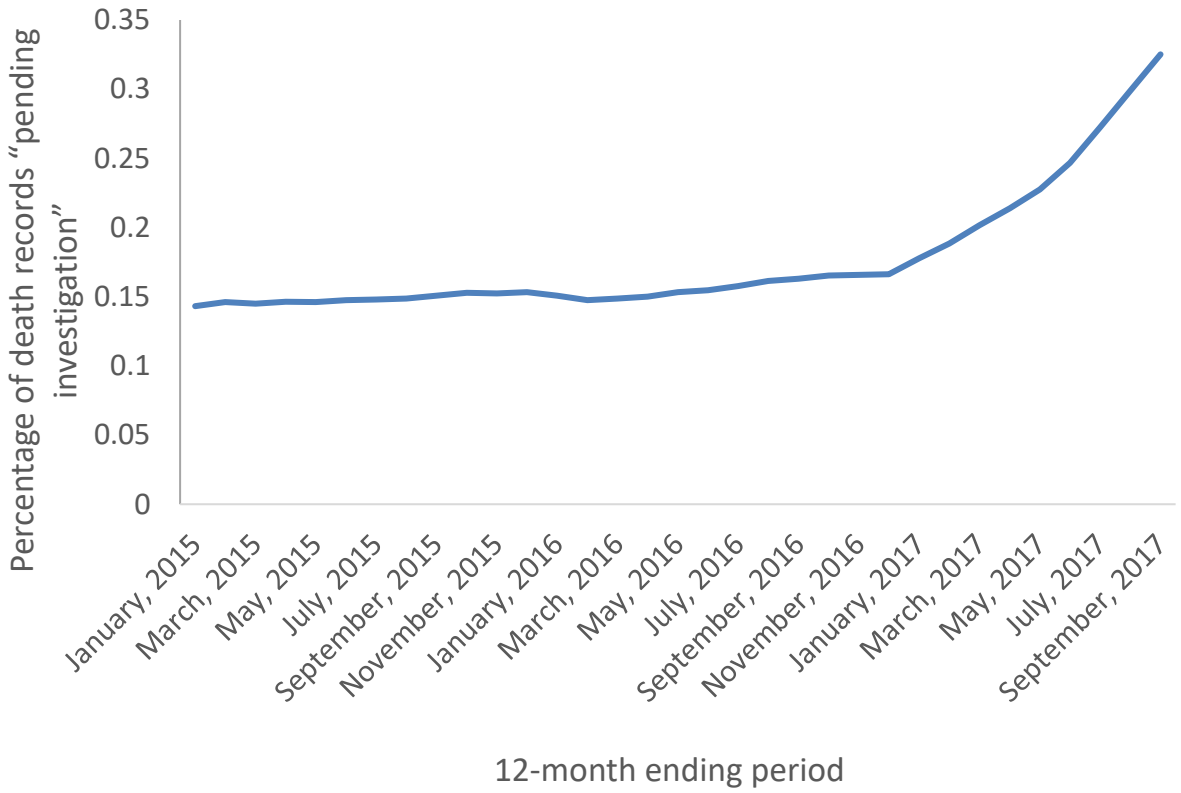
Figure 3. Average completeness of provisional counts of drug overdose death certificate records relative to final counts after a 6-month lag, by 12-month ending period.



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

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

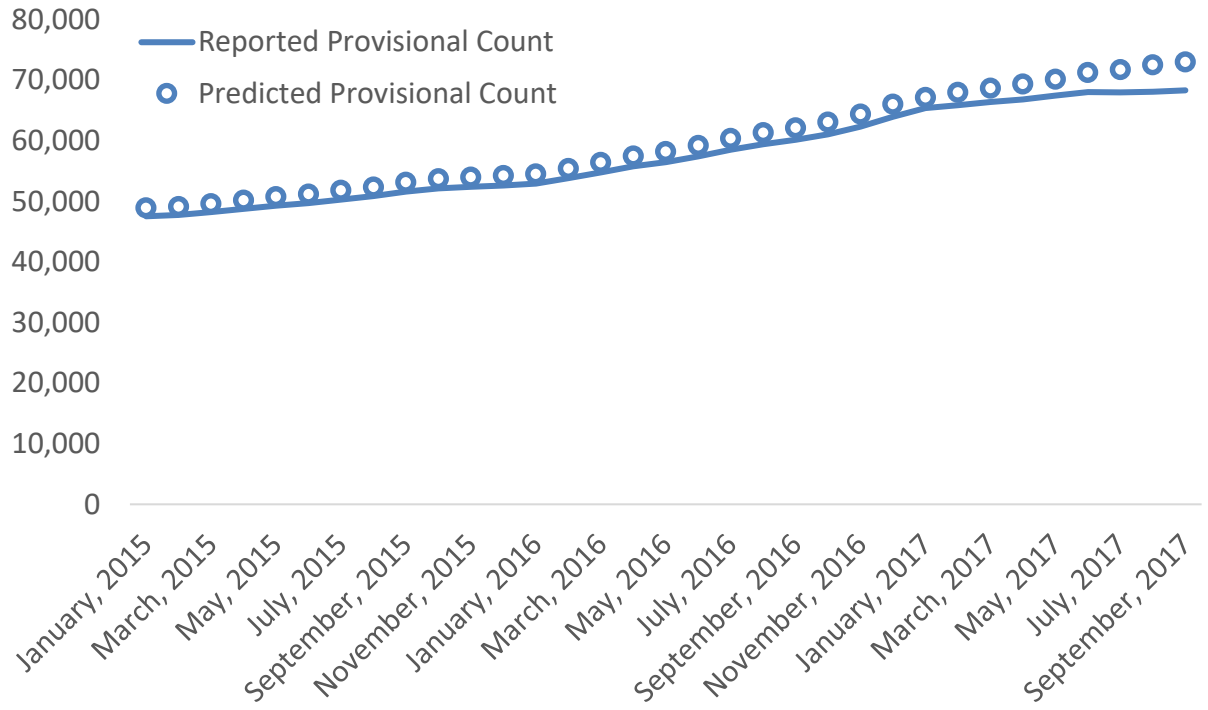
Figure 4. Percentage of death records with manner of death reported as "pending investigation", by 12-month ending period: United States.



NOTE: Counts are for the 12-month ending periods ending in the month indicated.

DATA SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

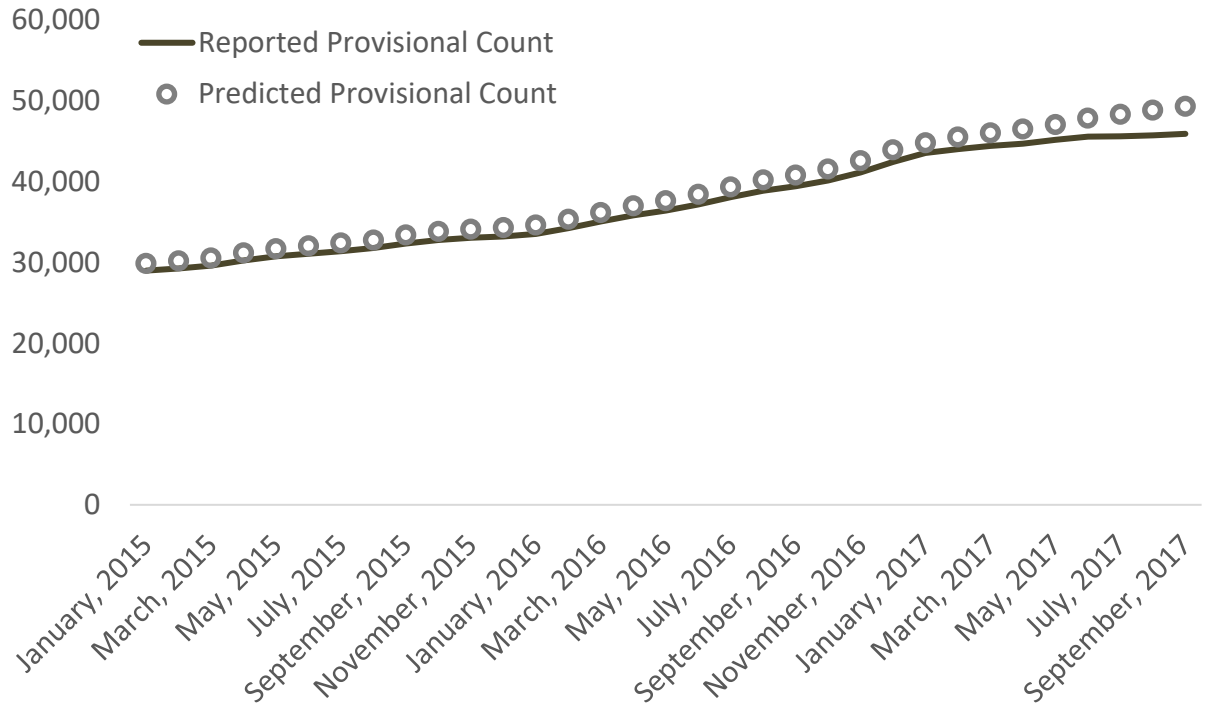
Figure 5. Predicted and reported provisional counts of drug overdose deaths, by 12-month ending period.



NOTE: Counts are for the 12-month ending periods ending in the month indicated.

DATA SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

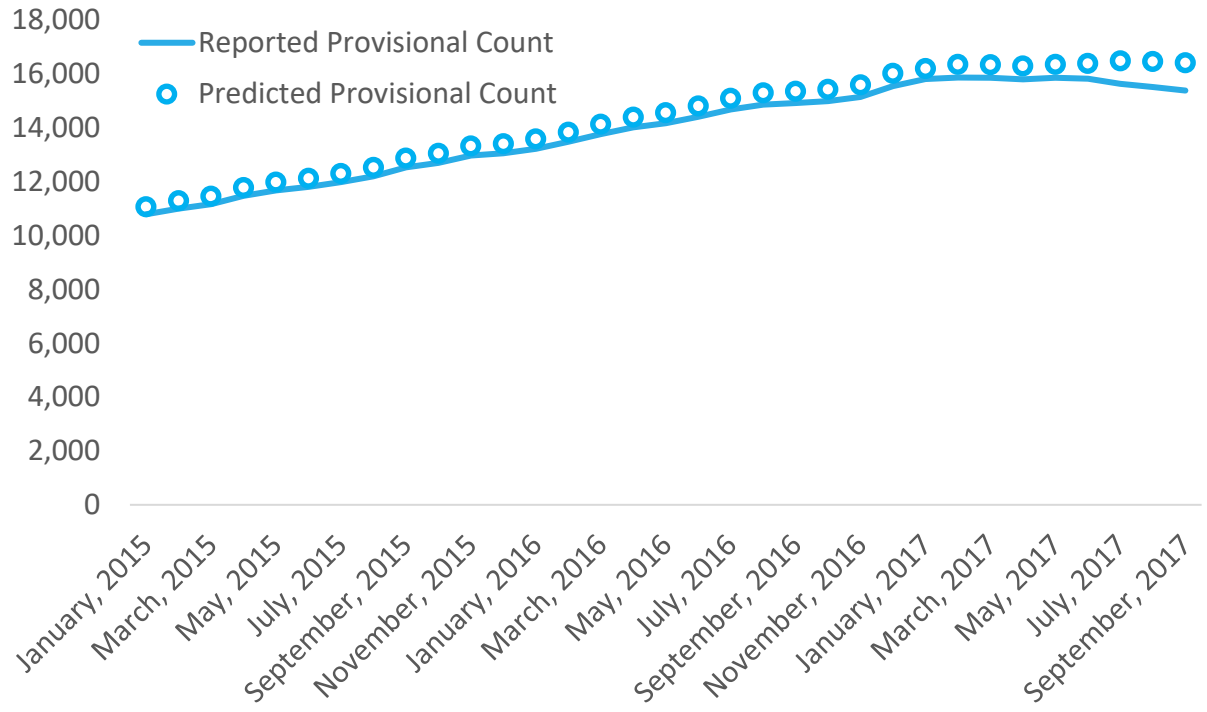
Figure 6. Predicted and reported provisional counts of drug overdose death counts involving any opioid, by 12-month ending period.



NOTE: Counts are for the 12-month ending periods ending in the month indicated.

DATA SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

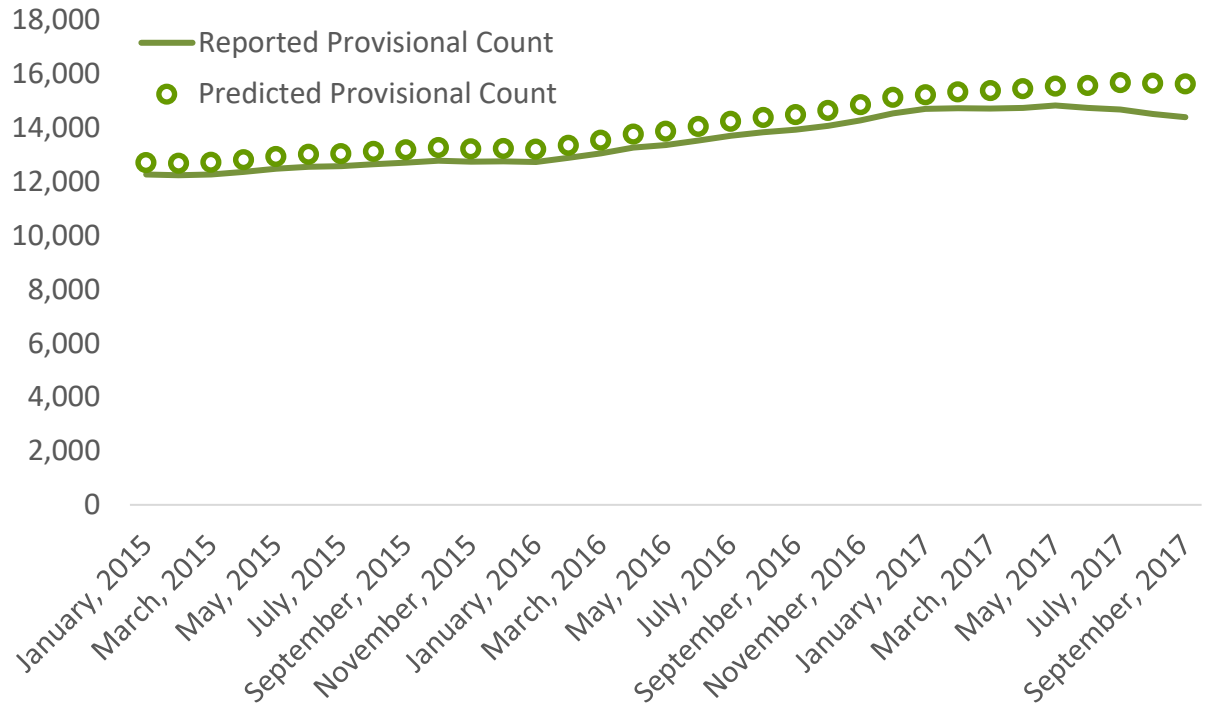
Figure 7. Predicted and reported provisional counts of drug overdose death counts involving heroin, by 12-month ending period.



NOTE: Counts are for the 12-month ending periods ending in the month indicated.

DATA SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

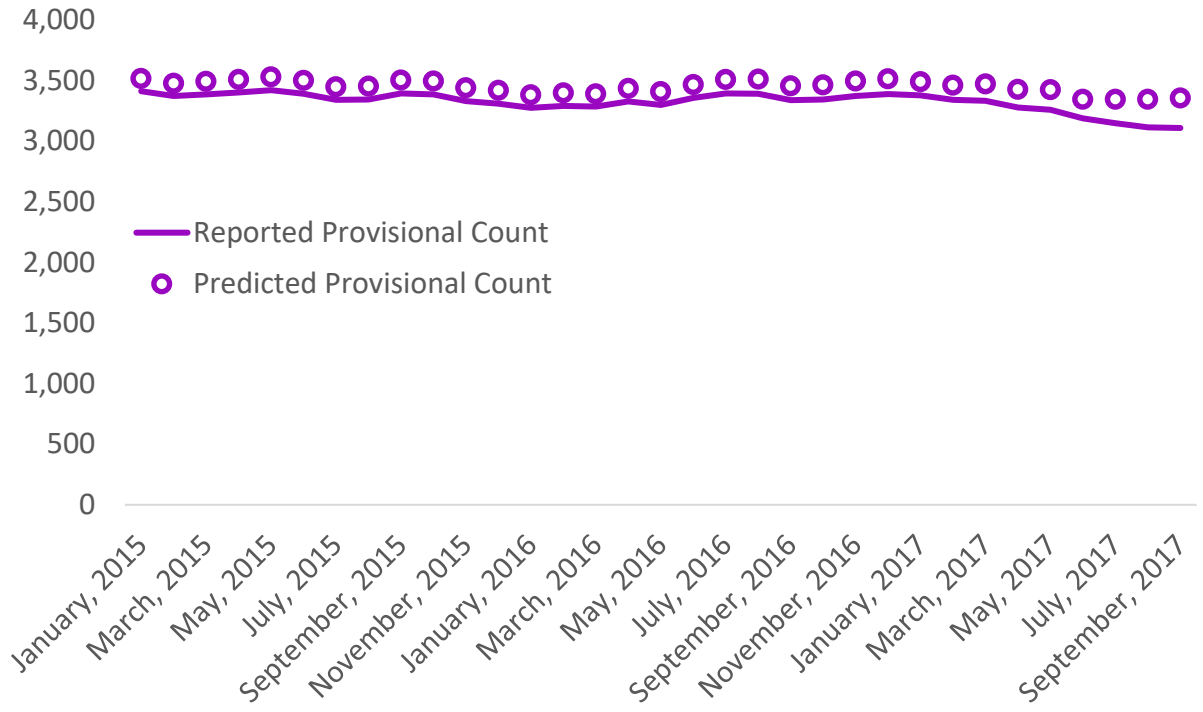
Figure 8. Predicted and reported provisional counts of drug overdose death counts involving natural and semi-synthetic opioids, by 12-month ending period.



NOTE: Counts are for the 12-month ending periods ending in the month indicated.

DATA SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

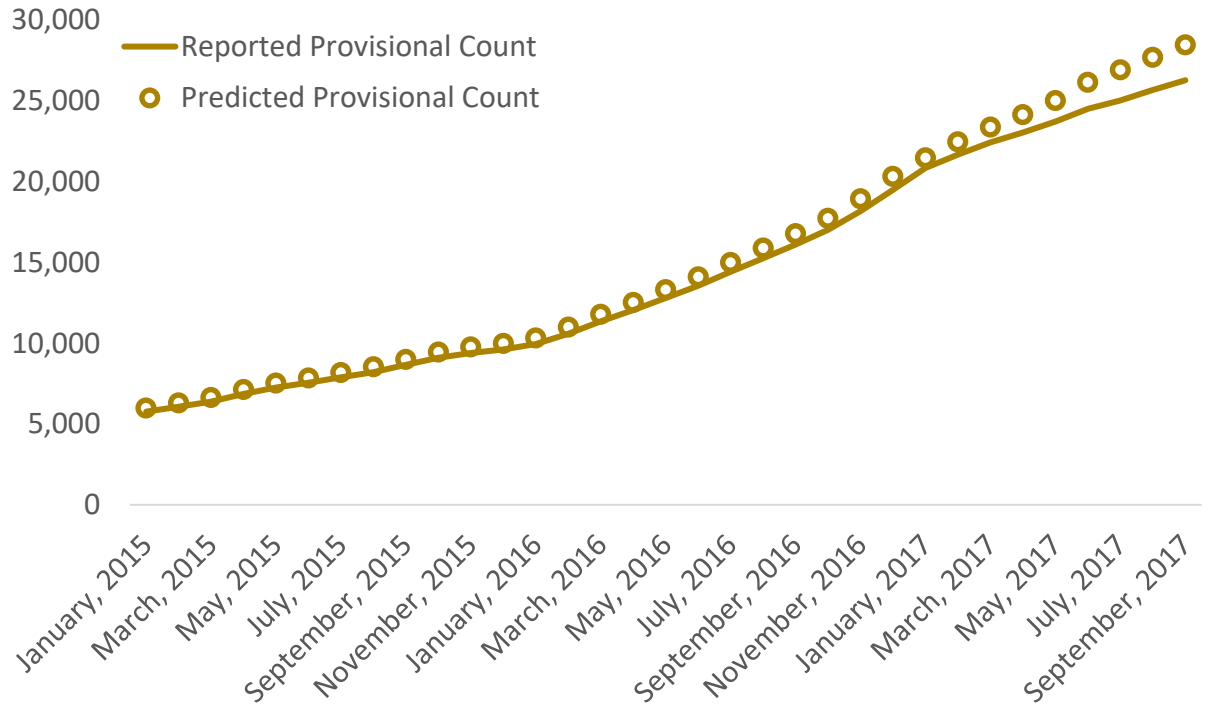
Figure 9. Predicted and reported provisional counts of drug overdose death counts involving methadone, by 12-month ending period.



NOTE: Counts are for the 12-month ending periods ending in the month indicated.

DATA SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

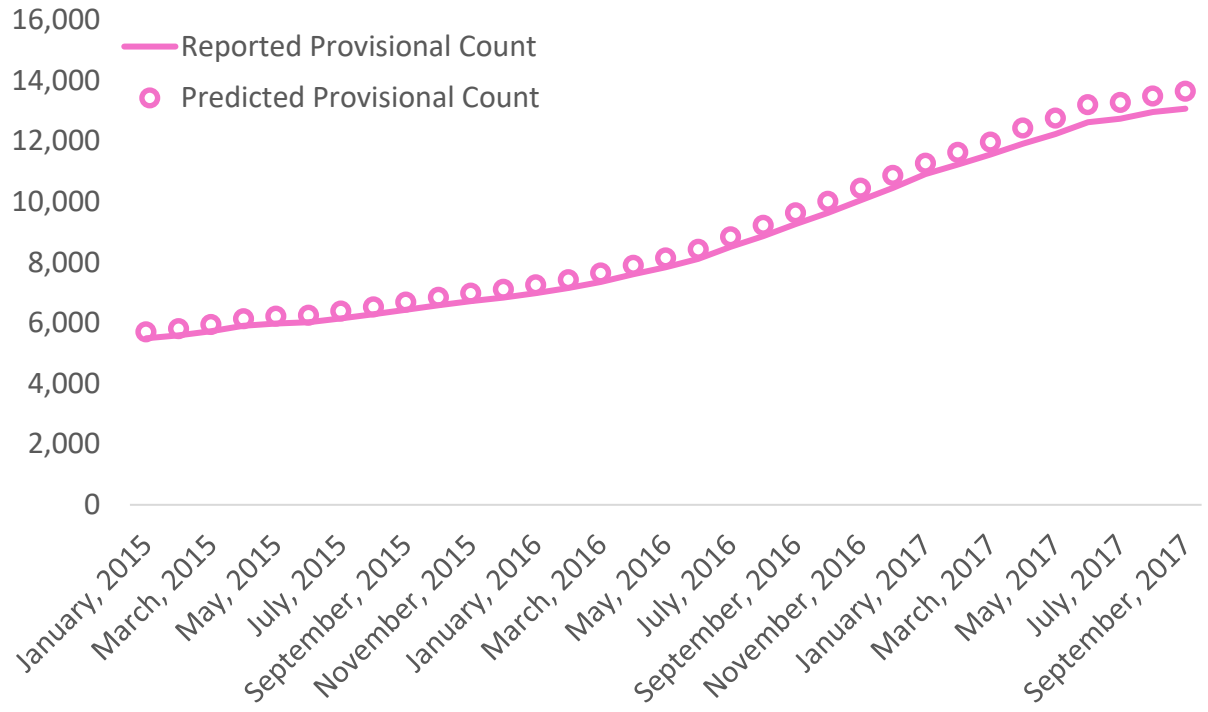
Figure 10. Predicted and reported provisional counts of drug overdose death counts involving synthetic opioids (excluding methadone), by 12-month ending period.



NOTE: Counts are for the 12-month ending periods ending in the month indicated.

DATA SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

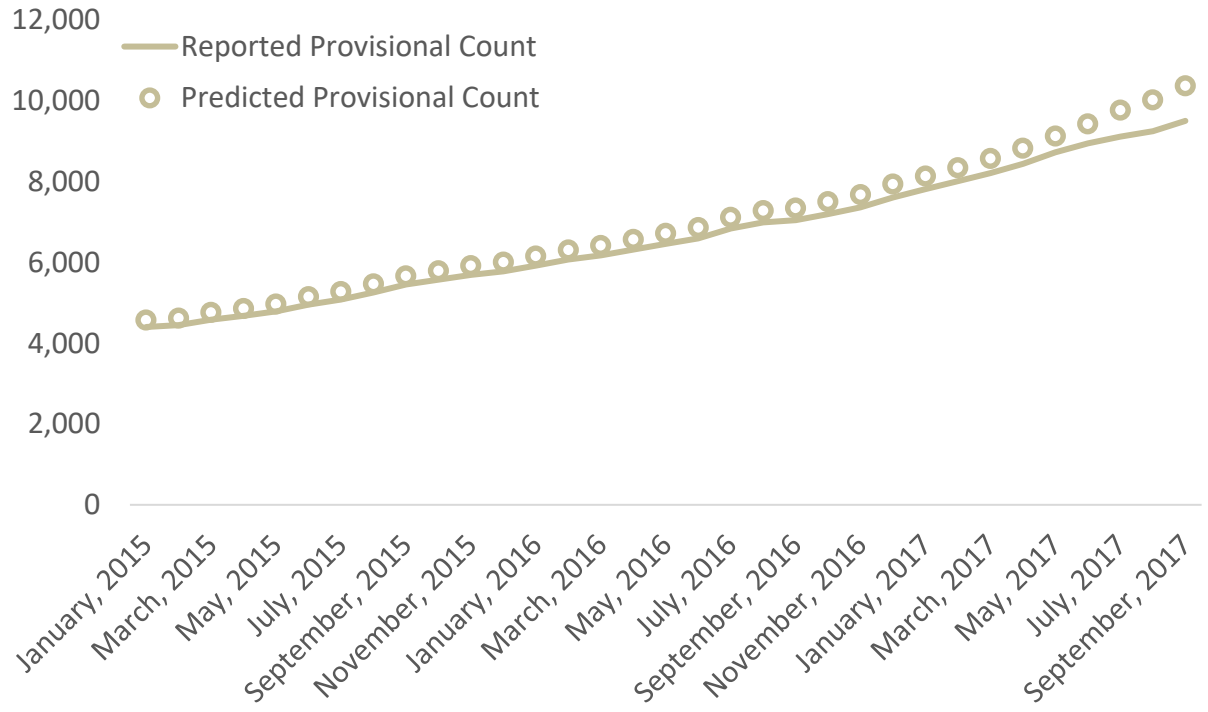
Figure 11. Predicted and reported provisional counts of drug overdose death counts involving cocaine, by 12-month ending period.



NOTE: Counts are for the 12-month ending periods ending in the month indicated.

DATA SOURCE: NCHS, National Vital Statistics System, April 15, 2018.

Figure 12. Predicted and reported provisional counts of drug overdose death counts involving psychostimulants with abuse potential, by 12-month ending period.



NOTE: Counts are for the 12-month ending periods ending in the month indicated.

DATA SOURCE: NCHS, National Vital Statistics System, April 15, 2018.