Rate Algorithms for the California Overdose Surveillance Dashboard are based on the National Cancer Institute Surveillance, Epidemiology, and End Results Program (SEER) calculations.

Crude Rate
A crude rate is the number of new cases (or deaths) occurring in a specified population per year, usually expressed as the number of cases per 100,000 population at risk.

$$cruderate = \frac{count}{population} \times 100,000$$

Age-Adjusted Rate
An age-adjusted rate is a weighted average of crude rates, where the crude rates are calculated for different age groups and the weights are the proportions of persons in the corresponding age groups of a standard population. The California Overdose Surveillance Dashboard uses the U.S. 2000 standard population when calculating age-adjusted rates as recommended by The National Center for Health Statistics. The age-adjusted rate for an age group comprised of the ages x through y is calculated using the following formula:

$$aarate_{x-y} = \sum_{i=x}^{y} \left[\left(\frac{count_i}{pop_i} \right) \times\ 100,000 \times\ \left(\frac{stdpop_i}{\sum_{j=x}^{y} stdpop_j} \right) \right]$$

where count is the number of cases for the i^{th} age group, pop_i is the relevant population for the same age group, and $stdpop_i$ is the standard population for the same age group.

Standard Error for a Crude Rate
This calculation assumes that the counts have Poisson distributions.

$$SE_{crude} = \frac{\sqrt{count}}{population} \times\ 100,000$$

Crude Rate Confidence Intervals
The endpoints of a (1 - p) x 100% confidence interval are calculated as:

$$CI_{low} = \frac{\frac{1}{2}(ChiInv(\frac{p}{2}, 2 \times\ count))}{population} \times 100,000$$

$$CI_{high} = \frac{\frac{1}{2}(ChiInv(1-\frac{p}{2}, 2 \times\ (count+1)))}{population} \times 100,000$$

where Chi Inv (p,n) is the inverse of the chi-squared distribution function evaluated at p and with n degrees of freedom, and we define Chi Inv (p,0) = 0.
Although the normal approximation may be used with the standard errors to obtain confidence intervals when the count is large, we use the above exact method that holds even with small counts. When the count is large the two methods produce similar results.

See:

Johnson NL, Kotz S. Distributions in Statistics: Discrete Distributions. John Wiley, New York, 1969.

Fay MP, Feuer EJ. Confidence intervals for directly standardized rates: a method based on the gamma distribution. Statistics in Medicine 1997 Apr 15;16(7):791-801.

Age-adjusted Rate Confidence Intervals

Suppose that the age-adjusted rate is comprised of age groups x through y, and let:

$$w_i = \frac{stdpop_i}{(pop_i \times \sum_{j=x}^{y} stdpop_j)}$$

using the Fay and Feuer method (see above):

$$w_m = max(w_i)$$
$$z = w_m^2$$

$$v = \sum_{i=x}^{y} (w_i^2 \times count_i)$$

The lower endpoint of a (1 - p) × 100% confidence interval is calculated as:

$$CI_{low} = \left(\frac{v}{2 \times rate}\right) \times \left(ChiInv\left(\frac{p}{2}, \frac{(2 \times rate^2)}{v}\right)\right) \times 100,000$$

$$CI_{high} = \left(\frac{v+z}{2(rate+w_m)}\right) \times \left(ChiInv\left(1 - \frac{p}{2}, \frac{2(rate+w_m)^2}{v+z}\right)\right) \times 100,000$$

This method for calculating the confidence interval was developed in Fay and Feuer (1997). The method produces similar confidence limits to the standard normal approximation when the counts are large and the population being studied is similar to the standard population. In other cases, the above method is more likely to ensure proper coverage.

Note: The rate used in the above formulas is not per 100,000 population.