Benzathine penicillin G (Bicillin L-A) forecasting tool: A spreadsheet-based tool for estimating penicillin demand for the treatment of syphilis

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The findings and conclusions in this work are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Contents

Introduction

This is a tool that uses local cases of syphilis (all stages) to forecast demand for benzathine penicillin G (Bicillin L-A). It contains optional fields to allow health departments to input:

- The average number of cases presumptively treated per diagnosed case of primary, secondary (P&S), or early latent (EL) syphilis
- The percentage of syphilis cases treated with non-bicillin therapy
- The percentage of syphilis treated by the health department (i.e., the percentage of syphilis cases for which the health department provides treatment, even if treatment occurs in a non-health department setting)
- A custom multiplication factor, to allow programs to vary the forecast outside the range indicated by changes in the number of cases 2016-2017

The tool also has a number of features that limit the forecast in certain situations where the number of cases change in extreme ways (explained further below) or where the number of cases for any stage of syphilis declined between 2016 and 2017. This tool is therefore not mathematically precise in every situation, but is intended to provide an estimate of near-term future demand that goes beyond an estimate that is based only on the number of cases used in the previous year.

Tool Layout

	A	B	C	D	E	F	G	H	I	J	K
1	**BENZATHINE PENICILLIN G (BICILLIN L-A) SUPPLY FORECASTING TOOL**										
2											
3	Enter case count data for 2016 and 2017 in columns B & C. Doses used in 2016-2017 and forecast doses in 2018 and 2019 automatically populate										
4	Data can only be entered in the colored cells: must fill (green), or optional (yellow). Enter numbers only as indicated in the notes										
5											
6	Number of patients empirically treated per case of P&S or EL[1]	0									
7											
8		Probable / confirmed cases treated[2]		% change	Multiplication	Calculated doses used (2.4 mu)[4]		Forecast cases[5]		Forecast doses (2.4 mu)[4]	
9	Stage at treatment	2016	2017	2016-2017	Factor[3]	2016	2017	2018	2019	2018	2019
10	Primary and secondary	0	0	0.0		0	0	0	0	0	0
11	Early latent	0	0	0.0		0	0	0	0	0	0
12	Late latent	0	0	0.0		0	0	0	0	0	0
13	Late with clinical manifestations	0	0	0.0		0	0	0	0	0	0
14	Congenital[6]	0	0	0.0		0	0	0	0	0	0
15	Percentage of cases treated with non-bicillin therapy (enter as a number 0-100)[7]										
16	Total (cases or doses)	0	0	0.0		0	0	0	0	0	0
17	Inventory at start of calendar year 2018 or 2019										
18	Percentage of syphilis that is treated by the health department (enter as a number 0-100)[9]										
19	Need to order to meet expected demand									0	0

Case data (probable and confirmed) are entered in the green cells, columns B & C, rows 10-14. Inventory on hand at the start of the time period is entered in cells J17 & K17. If the number of presumptive cases treated per case of P&S and EL is known, it can be entered in cell B6. If the percentage of cases treated with non-penicillin therapy in 2016 and 2017 are known, they can be entered in cells B15 & C15; similarly, percentages of cases treated by the health department in 2016 and 2017 (if known) can be entered in cells J18 & J19. If the health

department would like to use a different multiplication factor to control for changes in demand other than that calculated using 2016-2017 case data, the factor(s) for each stage of syphilis can be entered in column E, rows 10-14. The forecast doses (2.4 million units [mu]) of benzathine penicillin G for 2018 and 2019 are shown in J19 & K19. These fields are described in greater detail below (mandatory fields first, followed by optional fields).

Cases (Probable and Confirmed)

Cases are entered in the green field in columns B & C, rows 10-14. Project areas wishing to use the tool for only a subset of syphilis stages, such as P&S, but not others, can leave the fields in the unused stages set to 0. If a health department would like to restrict the tool to only confirmed or reported cases, these can be entered.

Inventory at the Start of the Calendar Year

Starting inventory values for the number of 2.4 mu doses in 2018 (which should be known) and 2019 (which must be estimated) can be entered in cells J17 and K18, respectively. Although flagged as mandatory, the tool will work if no values are entered. If no values are entered, values of 0 will be used in the calculations.

Number of Patients Empirically Treated per Case of P&S or EL

Many health departments presumptively treated contacts of patients diagnosed with early syphilis (P&S, EL). By default, this number is set to 0.25 in the tool, meaning 1 presumptively treated contact per four diagnosed early syphilis cases. If local data exist to change this number, the local value can be entered in cell B6. This feature can be turned off by entering 0.

Multiplication Factor

The tool uses the change in cases from 2016-2017 to project the number of cases in 2018 and 2019. For example, if a health department has 10 cases of P&S in 2016 and 15 cases in 2017 has experienced a 50% increase in the number of cases between 2016 and 2017. To estimate the number of cases in 2018, 50% will be added to the number of cases in 2017 (50% of 15 = 8, meaning 23 cases will be estimated for 2018). For 2019, 50% will be added to the number of estimated cases in 2018; 50% of 23 = 12, meaning 35 cases will be estimated for 2019). Note that the formulas round to the nearest whole number. Also, note that in all cases the multiplication factor is applied to the number of cases in 2017. There are some limitations to avoid extremes in the numbers of cases projected; see the Algorithm section.

If a health department expects the future demand to deviate from the 2016-2017 percentage change, a custom multiplication factor can be used; these numbers are entered in column E, rows 10-14. Health departments that would like to build in additional supply to represent an increasing trend or to reduce the rate of change can do so by entering a custom multiplication factor. The multiplication factor can vary by stage of disease: for

example, a health department that successfully engages prenatal care providers in expanding syphilis screening may expect congenital cases to be flat or declining in 2018 relative to 2017, even if congenital syphilis increased between 2016 and 2017. A multiplication factor of 0 could be entered in cell E14, leaving the other multiplication factor cells empty.

Note that the multiplication factor will override the percentage change 2016-2017. Using the example above (10 cases of P&S in 2016 and 15 cases of P&S in 2017), if 0 is entered as a multiplication factor in cell E10, the projected cases in 2018 and 2019 will reflect a 0% change from 2017 (i.e., 15 cases in each subsequent year).

Also remember that the multiplication factor is the percentage *change*—in other words, to reflect an expectation that cases will double, enter 100.

Percentage of Cases Treated with non-Bicillin Therapy

If a health department has estimates of the percentage of syphilis cases (all stages) treated with alternative regimens, these values for 2016 and 2017 can be entered in cells B16 and C16, respectively. The value entered in C17 (if any) is used in the projections for benzathine penicillin G demand in 2018 and 2019. If no values are entered, 0% is assumed (i.e., all syphilis cases treated with benzathine penicillin G).

Percentage of Cases Treated by the Health Department

If a health department has estimates of the percentage of syphilis cases (all stages) that will be treated by the health department or for which the health department provides the treatment, these estimates for 2018 and 2019 can be entered in cells J18 and K18, respectively. If no values are entered, 100% treatment by the health department is assumed.

Calculated Doses Used (2.4 mu)

The calculated number of doses for 2016 and 2017 are based on the cases entered in columns B and C. Three doses are assumed to be used for late latent and late syphilis with clinical manifestations. One full dose of 2.4 mu is assumed to be used for treatment of congenital syphilis, even though smaller doses may be used. These totals are adjusted for empiric treatment for early syphilis, as noted above, and the percentage of cases treated with non-bicillin therapy (cells B15 & C15). These totals are not adjusted by the percentage of cases treated by the health department—the percentage of cases treated by the health department for 2016 and 2017 do not appear in the tool.

Forecast Doses (2.4 mu)

The forecasted doses for 2018 and 2019 appear in columns J and K. The forecast doses for each year and each stage are adjusted by the percentage of cases treated with non-bicillin therapy in 2017 (i.e., the 2017 value is

used for both 2018 and 2019). The forecast doses for early syphilis are adjusted by the number of patients empirically treated per case of P&S or EL, cell B6 (as noted above, 0.25 is used if no value is supplied by the user). The overall totals for 2018 and 2019 (all stages) are shown in cells J16 and K16, respectively.

Forecasted Need to Order

After mandatory and optional fields are populated, the tool will provide estimates of the number of 2.4 mu doses that need to be ordered to meet expected demand in 2018 and 2019. These will show in the range of pink cells, J19 (2018) and K19 (2019).

Algorithm

As noted in the introduction, the forecasting tool uses the percentage change for each stage 2016-2017 to estimate the number of cases in 2018 and 2019, with a few modifications to limit extreme projections.

To calculate the 2018 and 2019 forecast cases:

If 0 cases in 2016 and no multiplication factor is entered, then the number of forecast cases in 2018 and 2019 will be equal the case increase between 2016 and 2017 since the rate of increase cannot be calculated. For example, if 0 cases in 2016 and 1 case in 2017, then the forecast will be 2 cases in 2018 (increase of 1 from 2017) and 3 cases in 2019 (increase of 1 from the 2018 forecast).

If 0 cases in 2016 and a multiplication factor is entered, that factor is used to calculate the forecast cases for 2018 and 2019 based on the number of cases in 2017. For example, with 0 cases in 2016 and 1 case in 2017, if 50 is entered for the multiplication factor, the forecast cases for 2018 will be 2 (a 50% increase from 1 will equal 1.5 cases, which will be rounded up to 2) and for 2019 the forecast cases will be 3 (a 50% increase from 2 cases, which is the rounded forecast for 2018).

If the number of cases in 2016 exceeds the number of cases in 2017, the forecasted cases for 2018 and 2019 will equal the number of cases in 2016. In other words, if cases fall in 2017, the decline will be ignored for forecasting purposes. This is to avoid a shortfall in forecasted doses for 2018 and 2019 based on a 1-year decline. A 1-year decline may be an artifact of delayed reporting or limited screening rather than a true decline in cases. This assumption of equal rates in 2018 and 2019 based on the 2016 cases can be overridden using the multiplication factor column if desired. If any value (even 0) is entered in the multiplication factor, the cases for 2018 and 2019 will be estimated based on the number of cases in 2017, and the assumption of equality with 2016 will no longer be true.

For example, if 5 cases in 2016 and 4 cases in 2017, the change 2016-2017 is -20%. By default, the tool will project 5 cases in 2018 and 2019, equal to the number of cases in 2016. This can be overridden by inputting a multiplication factor in column E:

- If -20 is used, meaning the decline in cases is expected to continue at 20% per year, the forecast cases will be 3 for 2018 and 2 for 2019.
- If 50 is used, the forecast cases for 2018 will be 6 (50% increase from 4) and for 2019 the estimated cases will be 9 (50% increase from 6).
- If 0 is used, the number of forecast cases for 2018 and 2019 will be 4 (no change from 2017).