Laboratory Test Utilization Rate

Description: These instructions will demonstrate how to calculate the rate of use for a specific laboratory test. Utilization rates can be used for diagnostic stewardship initiatives, when the goal is to avoid unnecessary testing. Also, trending test utilization rates can help you understand if a change in testing practice might impact your ability to identify specific infectious outcomes or events. For example, antimicrobial stewards may want to track utilization of blood cultures, urine cultures, or *C. difficile* tests.

For this example, we'd like to track the utilization rate of blood cultures in an ICU on a monthly basis so we can evaluate the effects of a blood culture stewardship educational initiative.

$$\textbf{Test Utilization Rate} = \frac{\textbf{Number of Tests}}{\textbf{100 patient days}}$$

Data Sources:

1. Data from the local electronic health record (EHR) -- Calculating the test utilization rates will require laboratory data from the electronic health record (i.e., NOT from NSHN) for the numerator of the number of tests. Information on lab tests requires working with your local data and/or informatics analyst who has knowledge of the lab information system (LIS) tables in your EHR.
2. NHSN Modules -- The denominator for test utilization rates can be obtained from NHSN modules (e.g. either patient days from the HAI modules or days present from the AU module). You may need to get access permissions from the infection prevention facility administrator to access HAI modules.

We expect that the proposed NHSN module for hospital-onset bacteremia (HOB) may provide structure to calculate blood culture utilization rates, but this module is not yet released (as of Summer 2023).

Manipulating the Data

Numerator

The numerator for the lab utilization rate is the number of laboratory tests, or in this example blood cultures, which is outside of data NHSN can currently provide.

Culture data can be particularly complex to work with because more than one pathogen can grow from the same culture specimen, and a single patient-encounter can have more than one culture event. Also, cultures can have no growth or minimal growth of an organism that the lab doesn't identify (e.g. <10,000 CFU of a gram-positive organism). Finally, LIS systems include interim or preliminary results from cultures that are updated over time.

Thus, you'll need to work with an analyst familiar with the LIS tables for culture results, and specify that you want "final" results rather than preliminary result information and date/time values that represent the time of specimen collection and the unit where the specimen was collected. The dataset structure that provides all the information needed will require unique accession number and date/time of sample collection (**Table**). Depending on how data is structured in the LIS tables, there may be multiple rows for accession numbers associated with growth of more than one pathogen (e.g. *E. coli* and *B. fragilis* growing in the same blood culture set). In that situation, your analyst might need to remove duplicate rows prior to aggregating the counts of unique accession numbers by month. The table structure below is one way to collapse to a single row per accession number.

You also might want to explore if the counts of tests already exist in support of other quality improvement projects. For example, your hospital may already be tracking blood culture contaminants and have monthly test count data available.

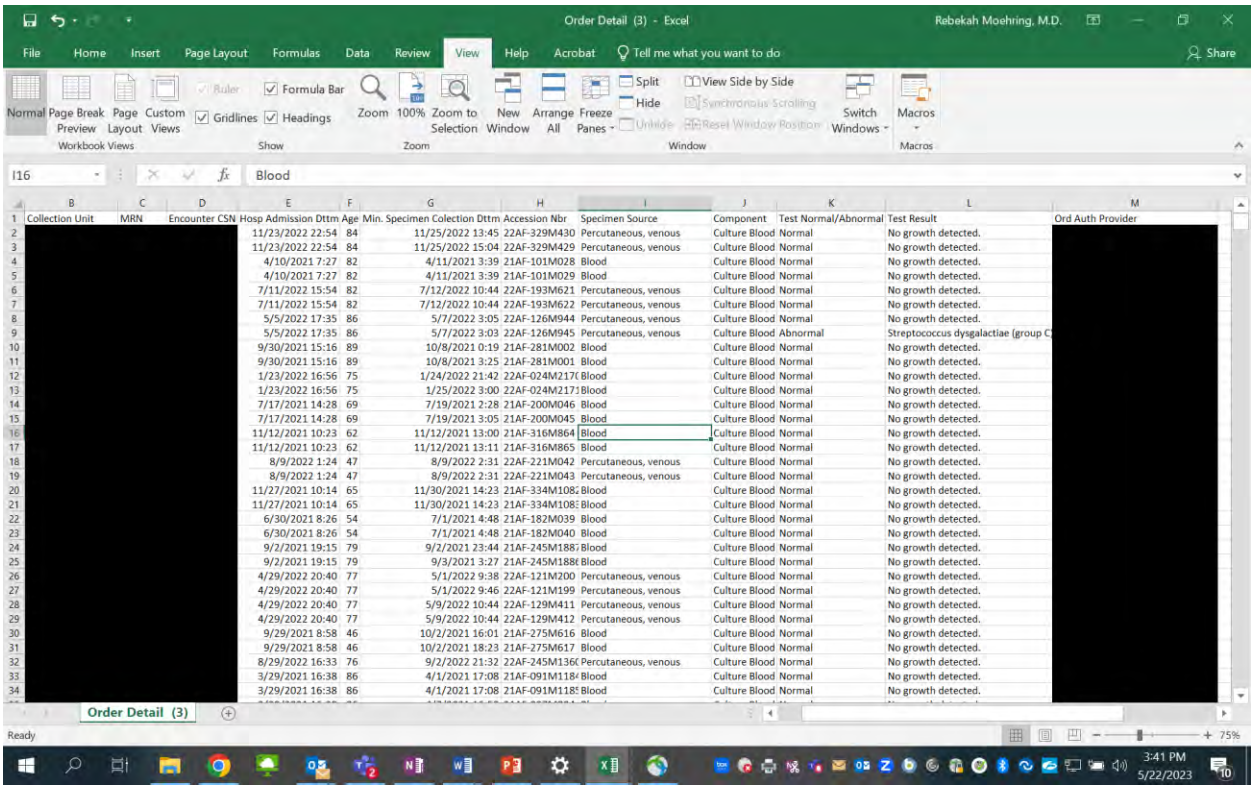
Inclusion or filtering criteria for this example is as follows:

1. Time period = 2021-2022
2. Location of specimen collection = limited to ICU
3. Specimen type = limited to blood
4. Component (Order or procedure type) = blood culture
5. Result type = limited to Final results (excludes preliminary results)

Table. Data Dictionary where 1 row is equal to one accession number

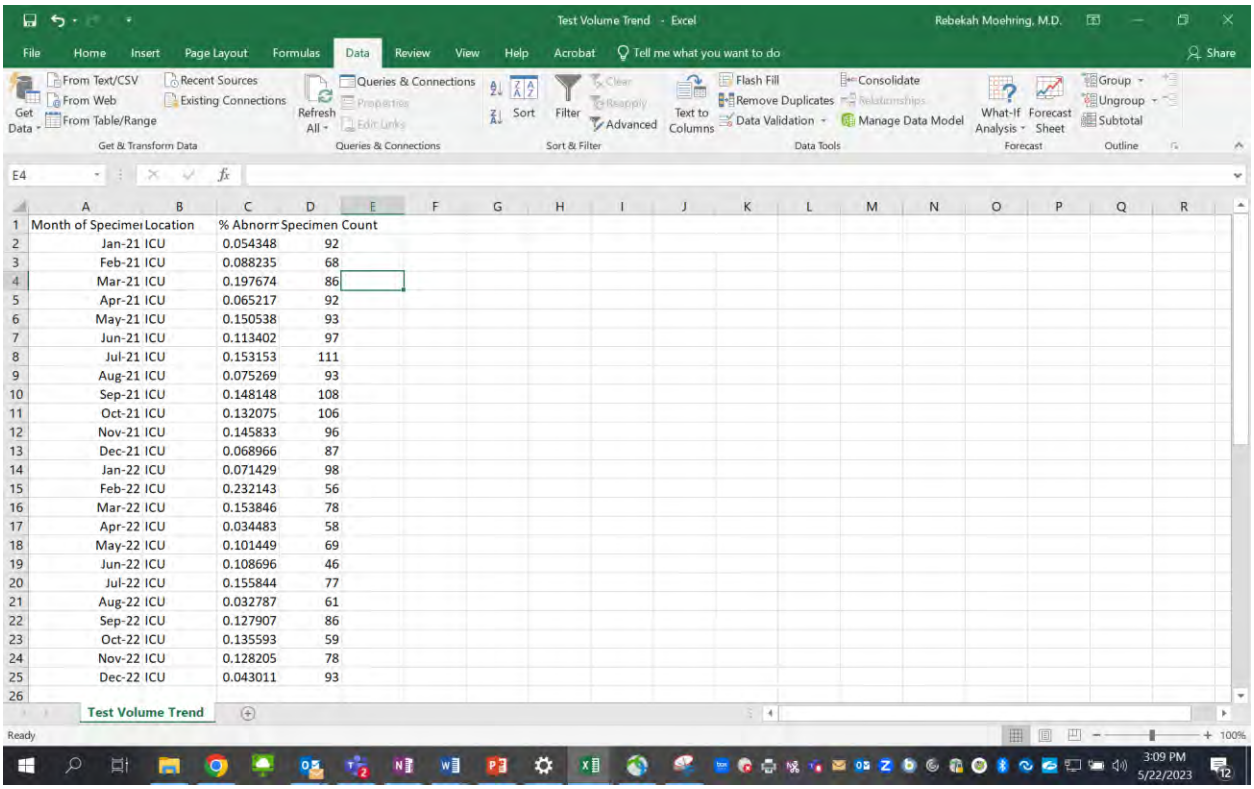
Field	Description	Format	Examples of values
PatientID (or MRN)	Patient identifier	Character	
Encounter (or admission)	Encounter identifier	Numeric	
Accession Number	Unique accession number for the culture specimen	Numeric	14AF-100466
Date/Time of Specimen Collection	Date and time when specimen was collected	Date time	31MAR2023 15:32
Location	Location or Unit where specimen was collected	Character	MICU; 6West
Specimen source	Body site where specimen was collected	Character	Percutaneous, venous; Central line; Dialysis catheter
Component	Order or procedure type	Character	Blood culture
Result	Abnormal or Normal flag for test result	Character	Normal; Abnormal
Test Result	Test result, typically including the name of pathogen or no growth.	Character	No growth; Staphylococcus capitis

Figure: Screenshot of granular data (Identifiers have been removed)



Then, your analyst would use the granular data to create monthly counts of tests/accession numbers. The abnormal test prevalence could also be counted using the result indicator, where the number of abnormal results is divided by the number of tests.

Figure: Screenshot of aggregated data table including month, year, location, specimen count, abnormal test percent.



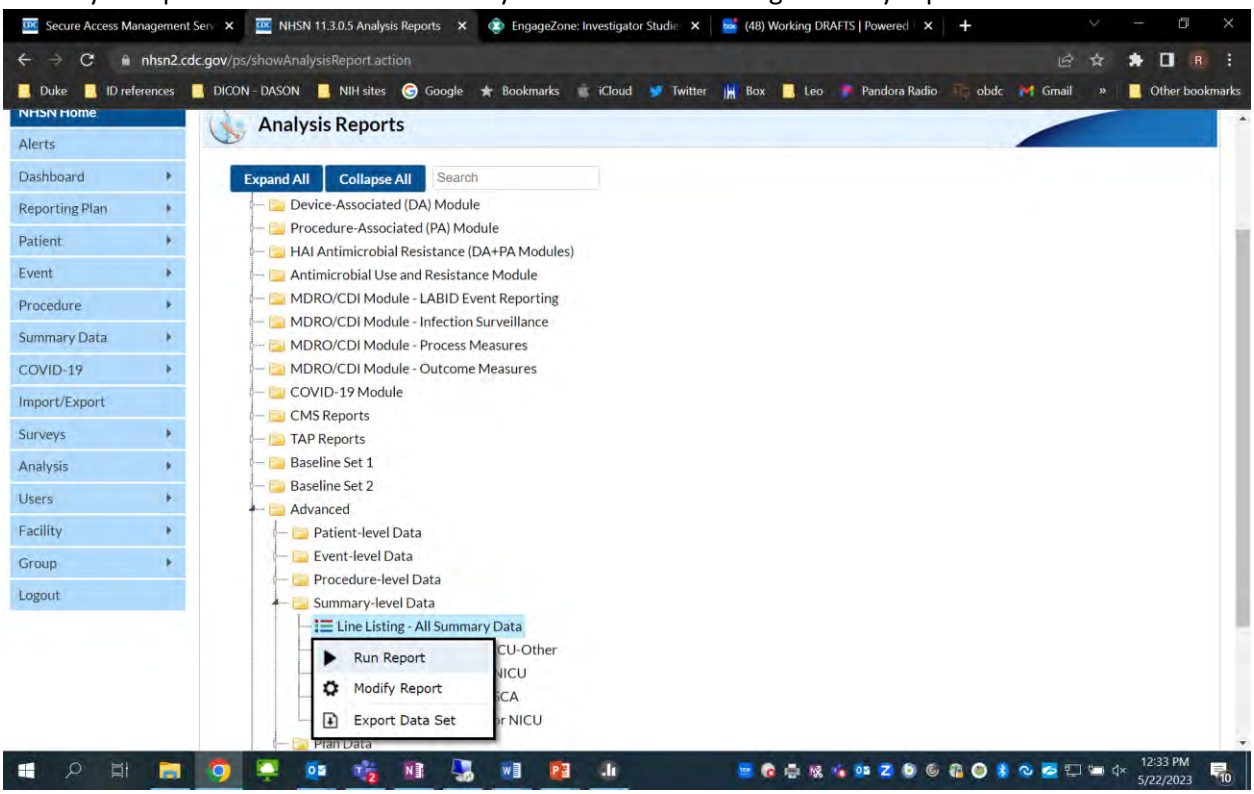
	A	B	C	D
1	Month of Specimen	Location	% Abnorm	Specimen Count
2	Jan-21	ICU	0.054348	92
3	Feb-21	ICU	0.088235	68
4	Mar-21	ICU	0.197674	86
5	Apr-21	ICU	0.065217	92
6	May-21	ICU	0.150538	93
7	Jun-21	ICU	0.113402	97
8	Jul-21	ICU	0.153153	111
9	Aug-21	ICU	0.075269	93
10	Sep-21	ICU	0.148148	108
11	Oct-21	ICU	0.132075	106
12	Nov-21	ICU	0.145833	96
13	Dec-21	ICU	0.068966	87
14	Jan-22	ICU	0.071429	98
15	Feb-22	ICU	0.232143	56
16	Mar-22	ICU	0.153846	78
17	Apr-22	ICU	0.034483	58
18	May-22	ICU	0.101449	69
19	Jun-22	ICU	0.108696	46
20	Jul-22	ICU	0.155844	77
21	Aug-22	ICU	0.032787	61
22	Sep-22	ICU	0.127907	86
23	Oct-22	ICU	0.135593	59
24	Nov-22	ICU	0.128205	78
25	Dec-22	ICU	0.043011	93
26				

Denominator

1. Finding the denominator for this calculation, or finding the total monthly patient days by location can be obtained through NHSN. Your analyst may also be able to provide these data easily from other quality improvement projects as this measure is used commonly for healthcare associated infection surveillance.

First, be sure that your facility administrator has given you access to the HAI modules, and not just the antibiotic use option, in order to get to the patient days denominators. After generating the datasets, go

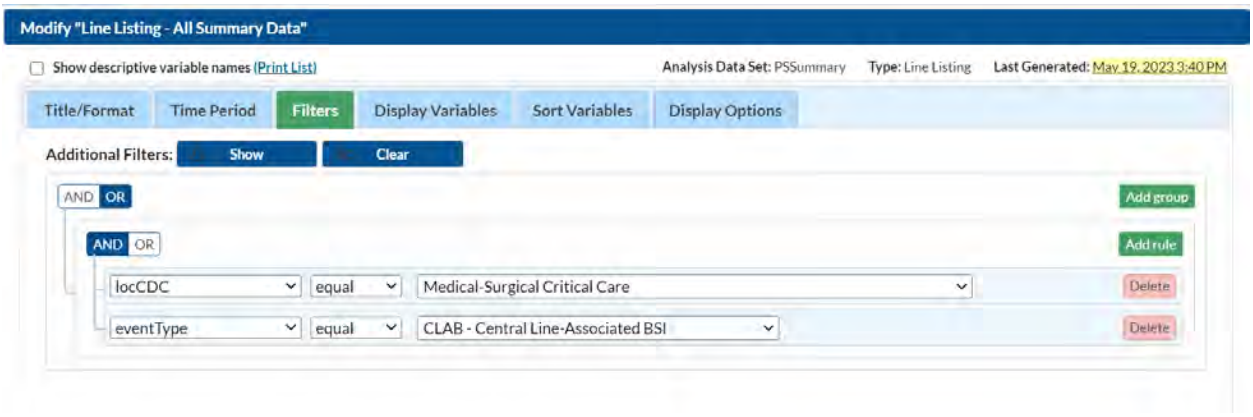
to Analysis reports – Advanced – Summary level data – line listing – modify report.



Next, select XLS for the output dataset.

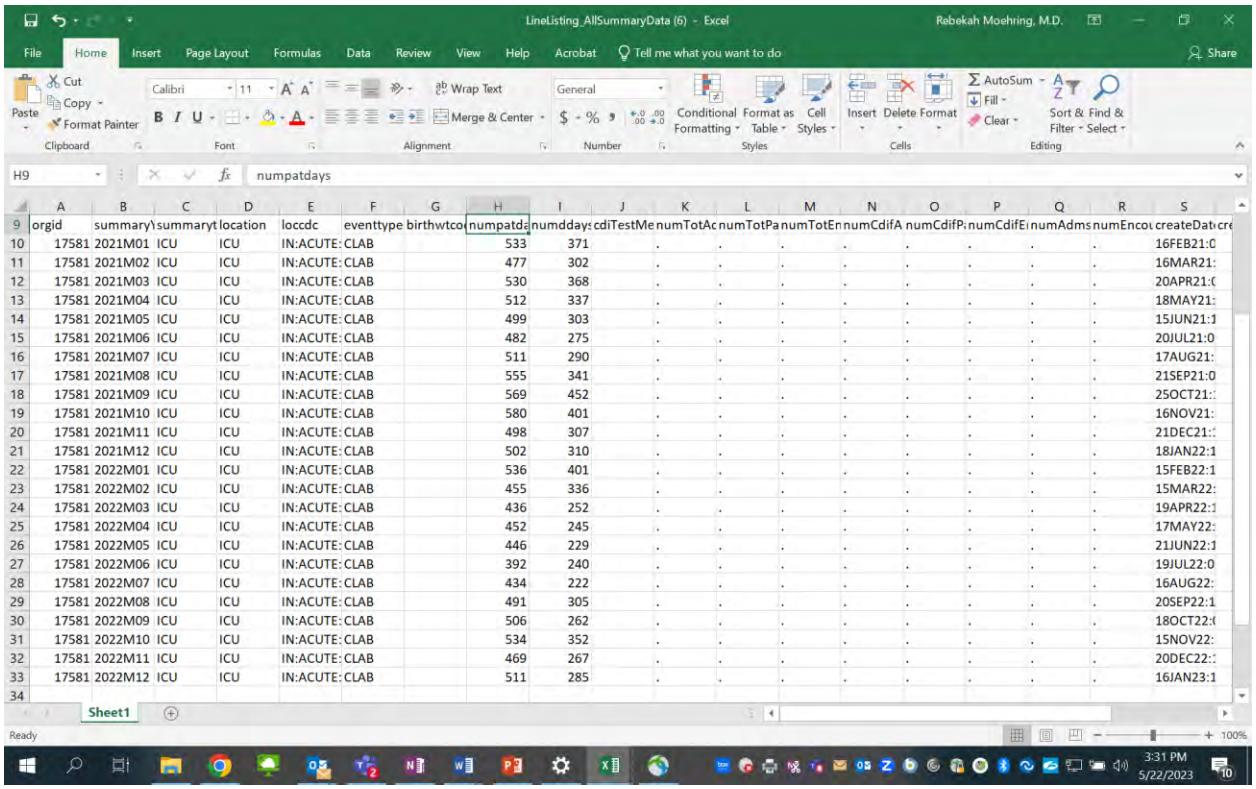
Specify the Time period – 01/2021 through 12/2022 for our example.

Filter to locCDC = Medical-Surgical Critical Care and eventType = CLAB so we can get single row data for our unit of interest. Our example hospital only has one critical care unit, by the way.



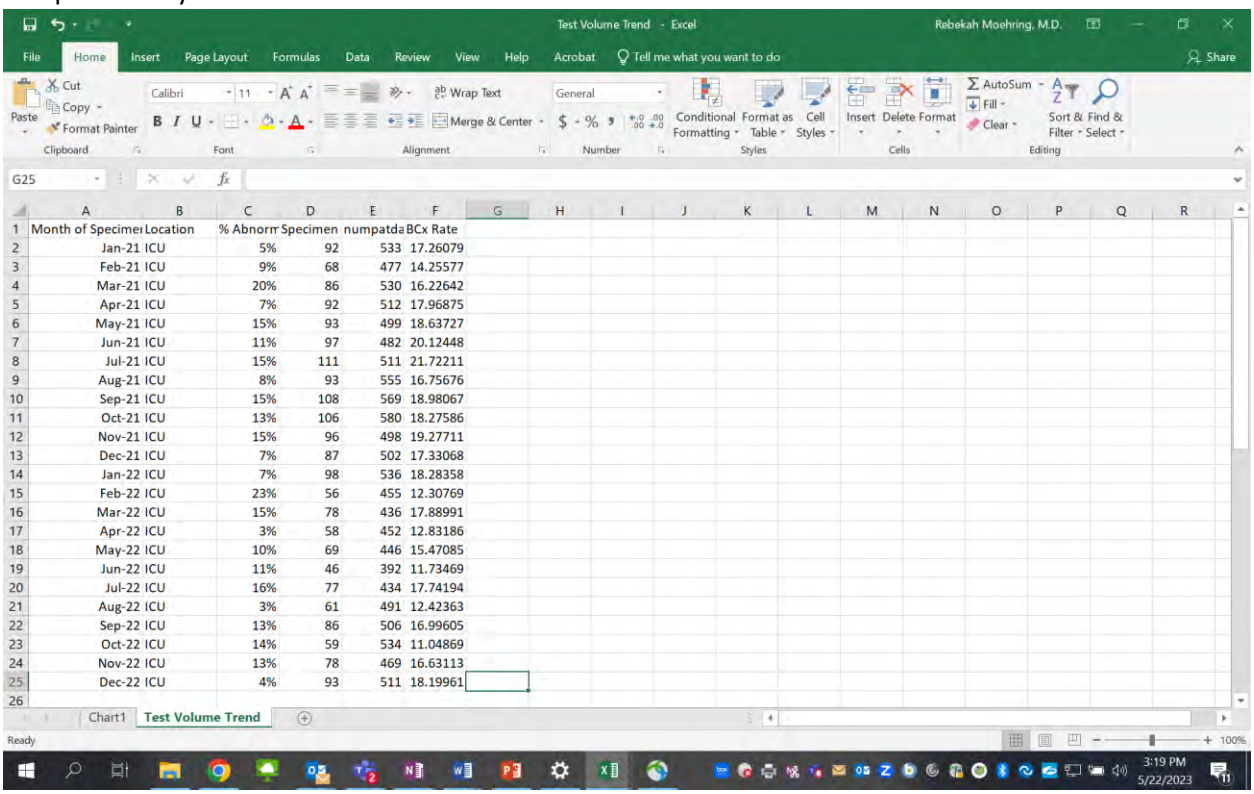
Run – Open the downloaded file.

2. Once exported into Excel, the data should look something like this:



The column of interest is labeled “numpatdays” which gives the number of patient days for that location or unit and month. Copy the “numpatdays” column into the same workbook you had your counts of tests.

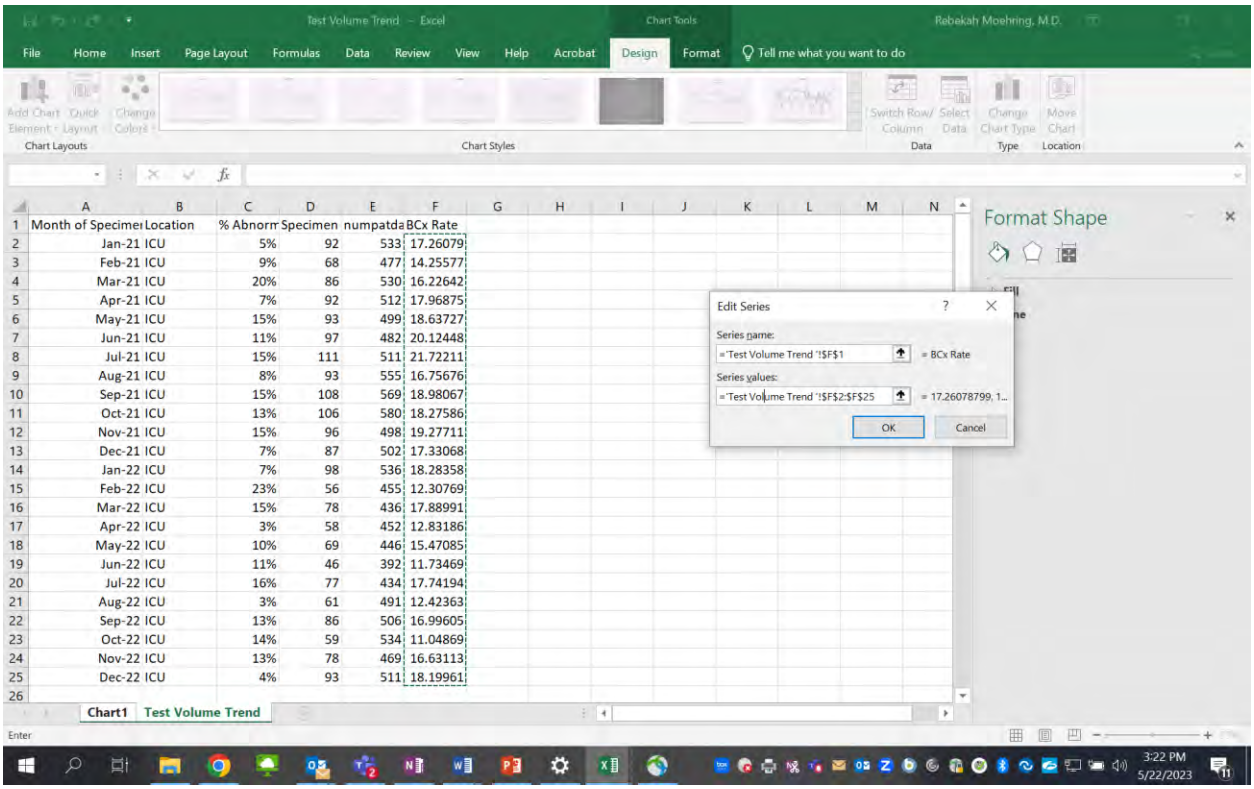
Then, you can calculate the rate using this formula: “=D2/(E2/100)”. This represents a testing rate per 100 patient days.



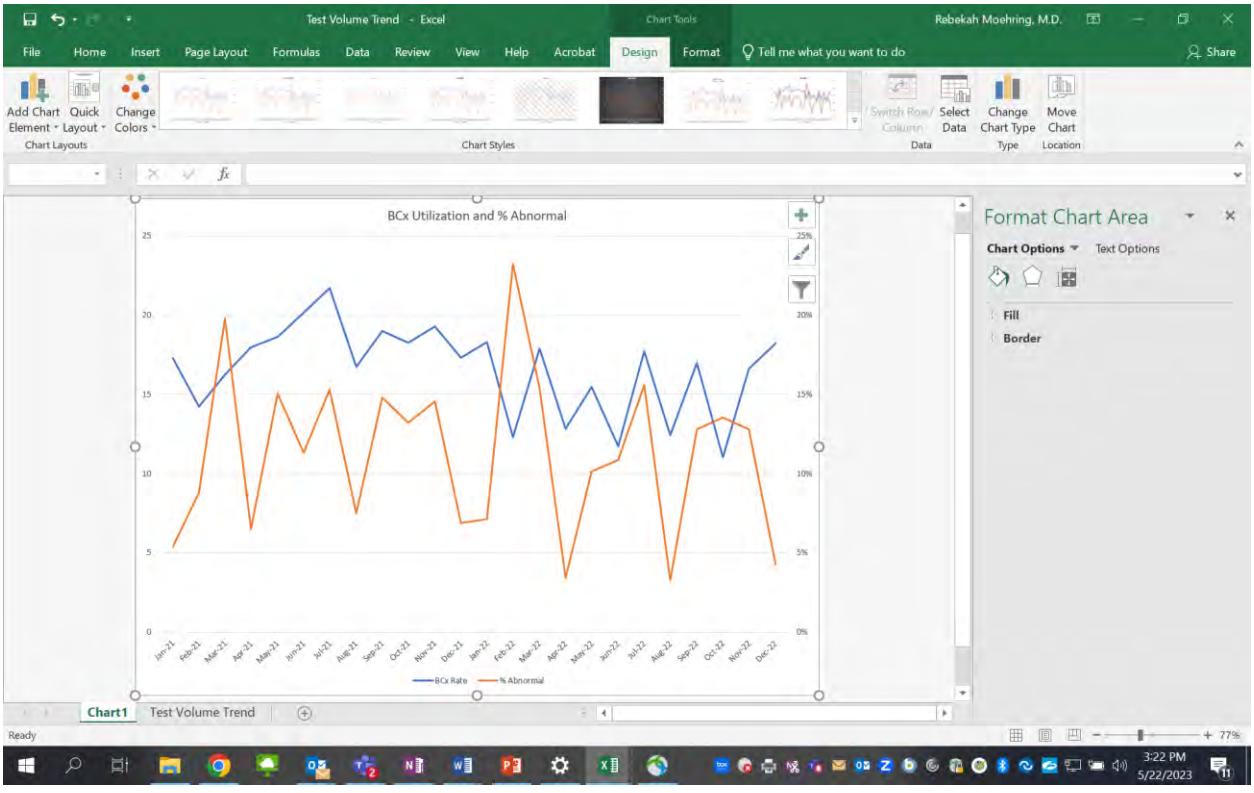
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Month of Specimen	Location	% Abnorm	Specimen	numpatda	BCx Rate												
2	Jan-21	ICU	5%	92	533	17.26079												
3	Feb-21	ICU	9%	68	477	14.25577												
4	Mar-21	ICU	20%	86	530	16.22642												
5	Apr-21	ICU	7%	92	512	17.96875												
6	May-21	ICU	15%	93	499	18.63727												
7	Jun-21	ICU	11%	97	482	20.12448												
8	Jul-21	ICU	15%	111	511	21.72211												
9	Aug-21	ICU	8%	93	555	16.75676												
10	Sep-21	ICU	15%	108	569	18.98067												
11	Oct-21	ICU	13%	106	580	18.27586												
12	Nov-21	ICU	15%	96	498	19.27711												
13	Dec-21	ICU	7%	87	502	17.33068												
14	Jan-22	ICU	7%	98	536	18.28358												
15	Feb-22	ICU	23%	56	455	12.30769												
16	Mar-22	ICU	15%	78	436	17.88991												
17	Apr-22	ICU	3%	58	452	12.83186												
18	May-22	ICU	10%	69	446	15.47085												
19	Jun-22	ICU	11%	46	392	11.73469												
20	Jul-22	ICU	16%	77	434	17.74194												
21	Aug-22	ICU	3%	61	491	12.42363												
22	Sep-22	ICU	13%	86	506	16.99605												
23	Oct-22	ICU	14%	59	534	11.04869												
24	Nov-22	ICU	13%	78	469	16.63113												
25	Dec-22	ICU	4%	93	511	18.19961												
26																		

Data Visualization

Once the counts are available in tabled format above, doing the rate calculation and then visualizing trends over time are relatively easy to do in Excel using a line graph functions.



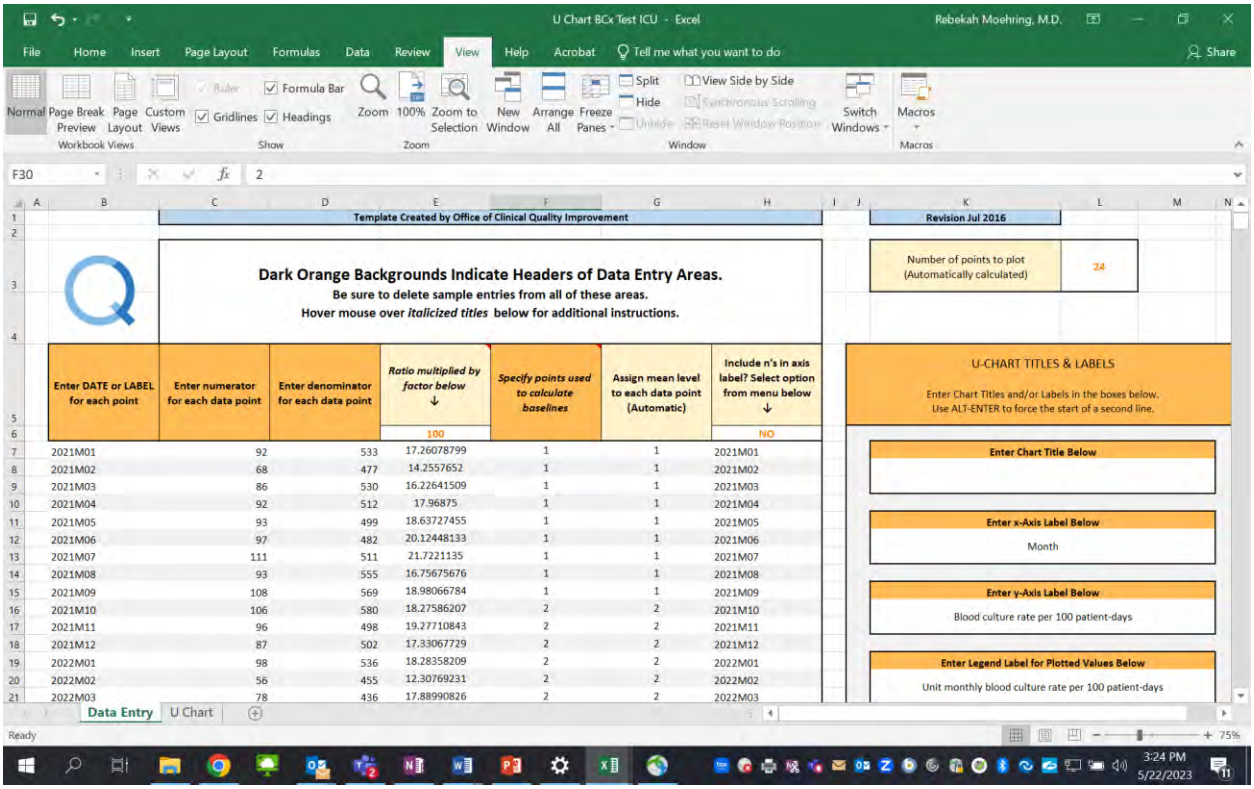
Month of Specimen	Location	% Abnorm	Specimen	numpatda	BCx Rate
Jan-21	ICU	5%	92	533	17.26079
Feb-21	ICU	9%	68	477	14.25577
Mar-21	ICU	20%	86	530	16.22642
Apr-21	ICU	7%	92	512	17.96875
May-21	ICU	15%	93	499	18.63727
Jun-21	ICU	11%	97	482	20.12448
Jul-21	ICU	15%	111	511	21.72211
Aug-21	ICU	8%	93	555	16.75676
Sep-21	ICU	15%	108	569	18.98067
Oct-21	ICU	13%	106	580	18.27586
Nov-21	ICU	15%	96	498	19.27711
Dec-21	ICU	7%	87	502	17.33068
Jan-22	ICU	7%	98	536	18.28358
Feb-22	ICU	23%	56	455	12.30769
Mar-22	ICU	15%	78	436	17.88991
Apr-22	ICU	3%	58	452	12.83186
May-22	ICU	10%	69	446	15.47085
Jun-22	ICU	11%	46	392	11.73469
Jul-22	ICU	16%	77	434	17.74194
Aug-22	ICU	3%	61	491	12.42363
Sep-22	ICU	13%	86	506	16.99605
Oct-22	ICU	14%	59	534	11.04869
Nov-22	ICU	13%	78	469	16.63113
Dec-22	ICU	4%	93	511	18.19961



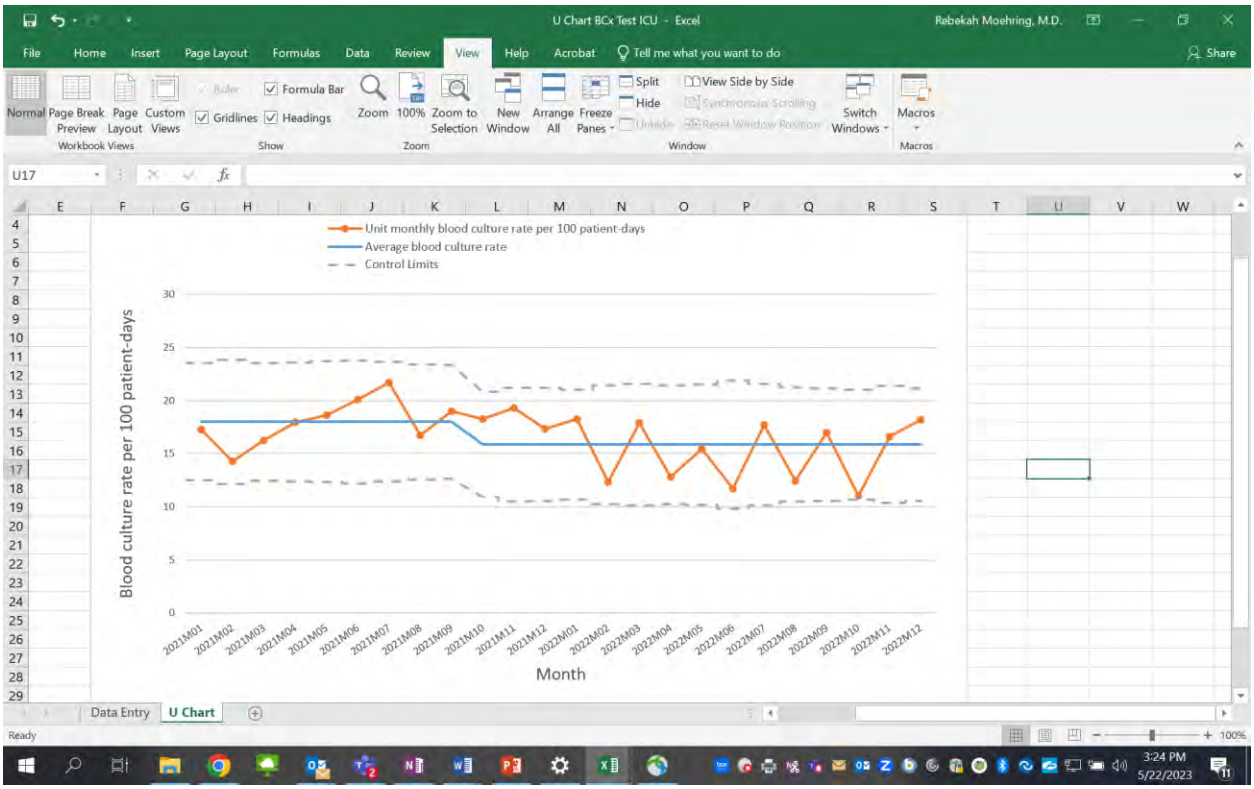
Another way to prospectively evaluate an intervention is to create a control chart or “run” chart with limits to identify a significant change in rate.

We have an example workbook here for you, created by investigators at John's Hopkins Hospital who have published multiple manuscripts focused on blood culture diagnostic stewardship. Dr. Valeria Fabre and colleagues are currently leading a multicenter implementation project for blood culture stewardship, supported by the CDC Prevention Epicenters Program [https://www.cdc.gov/hai/epicenters/johns-hopkins_univ.html]. The pilot project at Hopkins outlining the approach can be found in the Journal of Clinical Microbiology [https://pubmed.ncbi.nlm.nih.gov/32759354/].

To use this run chart, simply input the relevant data in columns for the number of tests and the number of patient days. Also, you can specify the baseline or intervention periods using a number (column F). In this example, we started our educational intervention in October 2021.



The means are helpful for comparison to see if the rate has shifted from the baseline during the intervention period. Also, if a point goes above or below the control limits (dotted lines), then you know that point was significantly different based on the expected trend. In our example, the mean Blood culture utilization rate went from 17.9 per 100 patient days to 15.9 per 100 patient days during the intervention period. Looks like there is still some work to do!


U Chart BCx Test ICU - Excel
Rebekah Moehring, M.D.
File Home Insert Page Layout Formulas Data Review View Help Acrobat Tell me what you want to do Share
Normal Page Break Preview Page Layout Custom Views Ruler Formula Bar Gridlines Headings Zoom 100% Zoom to Selection New Window Arrange All Freeze Panes Split Hide Unhide View Side by Side Synchronous Scrolling Reset Window Position Switch Windows Macros
Workbook Views Show Zoom Window Macros
U17
Unit monthly blood culture rate per 100 patient-days
Average blood culture rate
Control Limits
Blood culture rate per 100 patient-days
0 5 10 15 20 25 30
2021M01 2021M02 2021M03 2021M04 2021M05 2021M06 2021M07 2021M08 2021M09 2021M10 2021M11 2021M12 2022M01 2022M02 2022M03 2022M04 2022M05 2022M06 2022M07 2022M08 2022M09 2022M10 2022M11 2022M12
Month
Data Entry U Chart
Ready
100%
3:24 PM
5/22/2023