



*Photo credit:* Centers for Disease Control and Prevention

# User Manual: COVID-Vac (v.1)

Software for planning COVID-19 vaccination clinics and mass vaccination sites

*COVID-Vac (v.1)*

This manual accompanies the software tool COVID-Vac, which is an adaptation of the previously published Maxi-Vac and Maxi-Vac Alternative (at:

<https://www.cdc.gov/smallpox/bioterrorism-response-planning/max-vac/download-maxi-vac.html>

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## **Disclaimer**

The numbers generated through use of the software should not be considered predictions of what will occur while running a mass immunization clinic. Rather, they are estimates of what could occur. The findings and conclusions of this manual and software are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

## **System Requirements**

COVID-Vac uses the Windows\* operating system (Microsoft Windows 2010 or higher) and Excel (Microsoft Office 2013 or higher). Full functionality of COVID-Vac only is supported in the desktop version of Microsoft Office for Windows PCs. Some functionality of the tool may not be available in Microsoft Office for Mac or in the browser version of Office 365.

**NOTE: Upon opening COVID-Vac, users *must* click the button at the top of the document to enable macros.**

**Technical note: Readers are advised not to change the cell reference style from the standard, default A1 style to the R1C1 style as this will cause conflicts with the programming.**

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## Background

Throughout the trajectory of the COVID-19 pandemic, public health mitigation strategies such as masking, social distancing, and vaccination are critical for controlling the pandemic in the United States. COVID-19 vaccination of up to 80 percent of the population most effectively prevents SARS-CoV-2 transmission, reduces the severity of illness and death, and the associated burden on the health care system.

The Centers for Disease Control and Prevention of the U.S. Department of Health and Human Services released comprehensive guidance to help states, territories, and local communities plan and operationalize a vaccination response to COVID-19 within their jurisdictions. (See [COVID-19 Vaccination Program Operational Guidance | CDC](#) and [COVID-19 Vaccination Program Interim Playbook for Jurisdictions Operations Annex \(cdc.gov\)](#)).

As the COVID-19 pandemic evolves, there may be a need to reestablish large-scale vaccination sites across the United States to administer booster doses or reformulated COVID-19 vaccines to address new strains of SARS-CoV-2. Globally, as other countries receive COVID-19 vaccine doses, the need for vaccination clinics may arise.

COVID-Vac is a spreadsheet-based tool designed to assist managers of large-scale COVID-19 vaccination clinics plan for staffing needs and run their clinics to maximize patient flowthrough. COVID-Vac helps vaccination clinic managers allocate personnel such that a maximum number of people are vaccinated in a clinic during a 12 hour-period.

## Overview of COVID-Vac

COVID-Vac is an adaptation of a previously published tool, Maxi-Vac, which simulates a mass COVID-19 vaccination clinic. The tool, COVID-Vac, runs on a computer model that was developed using two mathematical simulation software programs (Arena® version 5.0, Rockwell Software, Inc. Sewickley, PA; OptQuest®, version 5.0, OptTek Systems, Inc., Boulder, CO). The simulations generated results shown in COVID-Vac and are based on observational data from large-scale vaccination clinics that anonymously recorded patients' overall time at a vaccination clinic, and at each clinic station. Additional input data were based on expert opinion of those operating a large-scale vaccination clinic.

The objective of the mathematical model is to allocate personnel in a way that allows the maximum number of people to be vaccinated in a clinic during a 12 hour-period. Built into the model is the stipulation that the average time individuals spend in the clinic is less than or equal to 180 minutes. The data generated by each model run are stored in COVID-Vac's database. Based on user inputs (e.g., the number of personnel

available for each 12-hour shift), the appropriate set of data is accessed in the database and displayed in the “Results” section of COVID-Vac.

## **Description of the Simulation Model**

A vaccination clinic consists of several staffed stations that a patient may “visit” during the vaccination process: welcome station, medical history and documentation, vaccination station waiting room, vaccination stations, and observation rooms. A mix of clinical and non-clinical personnel must staff stations included in the model. The tool supports over 1,100 different combinations of support staff, vaccinators, and client arrival rates to cover a wide range of vaccination site configurations.

### **Assumptions**

- The model includes only staff who have direct contact with individuals and excludes staff that have no interaction with clients (i.e., security, runners, data entry, etc.).
- A vaccination site operates for 12 hours with clinics ranging in capacity to serve approximately 300 to 11,000 individuals.
- Staff performance does not degrade over time.
- The number of individuals who enter the clinic is determined by the arrival rate.
- There is no limit on queue size or waiting rooms.
- Proof of registration takes place outside of the vaccination site.

## **Load, start, and navigation instructions**

Open the COVID-Vac spreadsheet and click the box at the top of the document that says, “Enable Macros,” or “Enable Content” (depending on which version of Excel is used). After enabling macros, click the “Start” button on the cover page to begin navigating the tool. If you encounter issues, contact [HEMU@cdc.gov](mailto:HEMU@cdc.gov) with the subject line [COVID-Vac tool inquiry].

## **Data Input**

COVID-Vac contains two worksheets in which users may enter the following information:

### **1. Staffing**

## 2. Arrival rate

Data entry cells are color-coded yellow in each worksheet; grey color-coded cells contain calculated values and other values that should not be modified.

**Note:** All user-entered information is saved automatically when exiting the tool. To change any value, simply type over the existing text.

## 1. Staffing

The Staffing worksheet includes three tables labeled “Support Staff,” “Vaccinators,” and “Auxiliary Staff (optional). There are four required steps and one optional step for users to enumerate vaccination site staffing needs.

Support Staff	
<i>Select number of support staff:</i>	<input type="text" value="30"/> pulldown menu
<i>Enter number of relief staff:</i>	<input type="text" value="15"/> Enter a number
<i>Full-time MD for observation room(s)*</i>	<input type="text" value="1"/>
<a href="#">*CDC reference document</a>	

Info about Support

Vaccinators	
<i>Select number of vaccinators:</i>	<input type="text" value="15"/> pulldown menu
<i>Enter number of relief vaccinators:</i>	<input type="text" value="10"/> Enter a number

Info about Vaccinators

### Step 1. Support Staff:

The user selects the number of support staff available from a pull-down menu containing twelve values ranging from 10 to 180. When selecting a value, it is important to keep in mind that support staff roles in COVID-Vac include personnel who have direct

contact with individuals arriving at the site to be vaccinated. Individuals move through the five vaccine site stations shown in the flow chart on tab 1, Staffing.

Users should include enough “base” support staff to cover these positions:

- *Welcome Station Greeter(s)*
- *Medical History and Documentation Staff*
- *Waiting Room Manager(s) for the Vaccination Station*
- *Observation Room Manager(s) for non-ADA Clients*
- *Observation Room Manager(s) for ADA Clients*

Anecdotal information suggests that two support staff are needed for every vaccinator. Per [CDC recommendations](#), the tool includes a default value for a full-time physician to staff the observation room(s).

**Step 2. Relief Support Staff:** The user enters the number of relief staff. To estimate the number of relief staff for a 12-hour shift, consider the number of additional support staff needed to allow for bathroom breaks, lunch breaks, days off, and unanticipated emergencies.

**Step 3. Vaccinators:** The user selects the number of vaccinators from a pull-down menu. The menu contains twelve values ranging from 5 to 90 vaccinators. The number of vaccinators needed to staff a mass vaccination site depends on the desired throughput rate but may be constrained by the availability of qualified staff in the surrounding area.

**Step 4. Relief Vaccinators:** Enter the number of relief vaccinators. To estimate the number of relief vaccinators, again consider how many additional vaccinators are needed to allow for bathroom breaks, lunch breaks, days off, and unanticipated emergencies.

**Step 5. Auxiliary Staff (optional):** In COVID-Vac, auxiliary staff are those who do not directly interact with individuals passing through the five vaccination site stations and are not included in the optimization model. Users may enter a value to enumerate auxiliary staff needs to help plan for overall staffing needs. If users enter a number for auxiliary staff, the tool will automatically populate the relevant cell in tab 3. Data Summary.

## Auxiliary Staff (optional)

Info about  
Auxiliary  
Staff

Enter number of Auxiliary staff:

Examples of auxiliary staff include site managers/leadership, pre-entrance screeners, parking and traffic control staff, vaccine inventory and storage managers, vaccine preparers, security/crowd management, runners, second-dose schedulers, data input/management staff, exit managers, and facility maintenance staff.

## 2. Arrival Rate

The table on this worksheet (shown below) contains a user input cell for the arrival rate and a calculated value for the expected number of individuals vaccinated over a 12-hour shift.

### Number of individuals arriving every minute

Info about  
arrival rate

Select number of people arriving per minute  pulldown menu  
Expected number vaccinated in 12 hours

The user selects an arrival rate from a pull-down menu that contains seven arrival rates ranging from 0.5 to 15 people per minute.

In general, when selecting the arrival rate, consider the size of the population to be served and how the vaccination site will manage individuals who arrive for vaccination. Walk-ins may be allowed, or many cases, vaccinations are scheduled so that the user may select the arrival rate that best matches the appointment schedule.

For example, if 30 individuals are scheduled to arrive per hour, select an arrival rate of 0.5, because that will give you 30 individuals arriving per hour (30 individuals/60 minutes = 0.5/min). If 900 individuals are scheduled to arrive per hour, select an arrival rate of 15 individuals/minute (900 individuals/60 minutes).



If unsure about which rate to select, users are encouraged to test a few different arrival rates to see how changes in the rate affect the need for staff, vaccinators, and waiting room space.

## Data Summary

The table on this worksheet (shown below) summarizes information users entered on tab 1, Staffing, and tab 2, Arrival Rate. If the user entered a value for Auxiliary Staff on tab 1, Staffing, that value will be reflected in the table on the Data Summary tab.

Support staff, vaccinators, and arrival rate				
	Base Staff	Relief Staff	Total	Auxilliary Staff*
Support Staff	30	15	45	
MD (Observation Room)	1			
Vaccinators	15	10	25	
Total Staff	46	25	70	10
Arrival rate	3			

\*Auxiliary staff are not included in the model for they do not impact the flow of individuals through the vaccination stations.

### What if an ERROR message appears?

#### Error Message Example 1

An error message will appear when the tool determines user inputs for support staff, vaccinators, and arrival time result in a combination that violates the assumption that an individual spends an average time of 3 hours at the vaccination site.

Support staff, vaccinators, and arrival rate				
	Base Staff	Relief Staff	Total	Auxiliary Staff*
Support Staff	80	50	130	
Vaccinators	25	45	70	
Total Staff	105	95	200	5
Arrival rate	15			

The error message will contain recommendations for modifying the staffing mixture to reduce the average time individuals will spend in the clinic to below 3 hours.

Sample error message:

**WARNING! 80 support staff will not work at 15 people per minute. Need at least 100 support staff and 50 vaccinators.**

Another situation in which an error message will appear is when the optimization tool determines there is a combination of fewer staff (support staff or vaccinators) that yields the same results obtained when the model runs user-input values.

If a message appears on tab 3, Data Summary, the same error message will appear on tab 4, Results – Staffing, tab 5, Results – Time, and tab 6, Results – Individuals per Station.

## Results

The COVID-Vac tool includes three “Results” tabs:

- staffing and optimal placement of staff;
- average and maximum time individuals spend at the vaccination site; and
- average and maximum number of individuals at the vaccination site and at each station.

The screen shots in the following sections are based on 30 support staff, 15 vaccinators, and an arrival rate of 3 people/minute.

**Results: Staffing and optimal placement of staff**

Tables 1 and 2 provide results from the simulation and optimization runs based on user inputs.

**Table 1** shows the number of total staff, with and without relief staff needed, and the average number of people that can be vaccinated at the clinic, broken down by ADA-status, based on the model assumptions. These values represent average numbers from over 100 runs of the simulation based upon the optimal placement of staff.

Table 1. Number of people vaccinated in 12-hour shift		
Total number of staff needed to operate all stations/12hr shift:	46	
Staff needed to operate all stations + relief staff/12hr shift:	70	
Total average number of people who can be vaccinated:	2,162	
non-ADA:	1,598	74%
ADA:	564	26%

**Table 2** displays the number of specific types of personnel needed at each station with percent (%) staff utilization at each station over a 12-hour shift.

**Table 2. Optimal placement of staff by station per 12-hour shift**

	Number of Staff	Staff Utilization
<b>Support Staff</b>		
Greeter	2	0.47
Medical History and Documentation Staff	24	0.82
Waiting Room Manager for the Vaccination Station	1	0.47
Observation Room Manager for non-ADA individuals	1	0.98
Observation Room Manager for ADA individuals	1	0.98
Total Support Staff	29	
Full-time MD for Observation Room (CDC Guidelines)	1	
<b>Vaccinators</b>		
Vaccinators for non-ADA individuals	10	0.87
Vaccinators for ADA individuals	5	0.76
Total Vaccinators	15	

### Staff Utilization

Staff utilization is the amount of time a staff member(s) is busy divided by the total time the staff is available. In COVID-Vac tool, a “busy” staff member is one who actively performs work duties, whatever those duties may be. For example, if a staff member is busy interacting with an individual patient for 15 minutes out of a total 60 minutes, staff utilization over that hour would be 15/60, or 0.25 (or 25%).

This metric provides two useful pieces of information. First, if this number is approximately 0.80 or above, that staff member or station is likely causing a bottleneck in the process. If staff is to be added, this information would indicate the station where the addition would be most advantageous. In the above example, the staff utilization at the non-ADA and ADA stations are over 0.80. This is another indication that these stations are creating a bottleneck. CAVEAT: After adding staff to that station (on worksheet tab 1, Staffing), the bottleneck may move. The only way to identify the cause of the new bottleneck is to re-examine the results after adding more staff, and in this example, adding more vaccinators. This metric indicates which staff might need additional support or relief. This is especially true if the staff utilization is nearing 0.80. It is difficult to maintain quality work at such a high utilization rate.

**Note: optimized staffing results** might not reflect the values entered by the user in tab 1, Staffing. For example, using inputs, 30 support staff, 15 vaccinators, and an arrival

rate of 3 people/minute, the total number of staff needed to support all stations/12hr shift is 46 (shown in Table 1 above). The optimized results (Table 2) show 29 support staff and 15 vaccinators, for a total of 44 staff. One support staff member was not included in the optimized results because that staff member added no value in minimizing the time individuals spend in the clinic.

**Results: Average time spent at vaccination site**

**Table 3** shows the average amount of time, in minutes and hours, individuals spend at the vaccination site overall.

Table 3. Average time individuals spend at vaccination site			
	Average (in minutes)	Average (in hours)	Hours Working after Clinic Doors Close
Total time clients spend in the clinic	32	0.5	
Total time non-ADA clients spend in the clinic	31	0.5	
Total time ADA clients spend in the clinic	35	0.6	
Time the clinic closes	760	12.7	0.7*

\* This means that the clinic will close approximately 40 minutes after the clinic doors close

The column labeled "**Hours Working after Clinic Doors Close**," reflects the amount of time, in hours, the clinic continues to operate after a 12-hour shift. The red color-coded note that appears below the table provides the amount of time in minutes the clinic continues to operate after the doors close.

**Results: Individuals in each station**

**Table 4** shows the average number and maximum number of individuals at the vaccination site, at each station, at any given time over a 12-hour shift.

<b>Table 4. Average No. clients in each station</b>		
	avg # people	maximum #
<b>Average number of clients in the clinic</b>	91	134
<b>Number of individuals waiting, by station</b>		
Greeter	1	2
Medical History	6	21
Waiting Room	4	21
Vaccinator	5	18
non-ADA Observation Area	26	28
ADA Observation Area	12	13

**Number of individuals waiting, by station**

Continuing with the example using inputs, 30 support staff, 15 vaccinators, and an arrival rate of 3 people/minute, Table 4 shows that on average, five people are in line at the Vaccinator Station, 26 people are in the non-ADA Observation Area, and 12 are in the ADA Observation Area.

**What if there are zeros?**

Some input combinations might return zeros in Table 4 under “Number of individuals waiting, by station.” If the table shows a zero in columns for average and maximum number of people at a particular station, that means individuals are moving through the station with no wait time.

## Appendix

The Table below shows the distribution used to estimate the time individuals spent at each station and the time taken to walk from one station to another.

The authors collected data at vaccination site stations to calculate a continuous probability distribution with a minimum, mean, and maximum time individuals spend at each station. We used the mean time with an exponential distribution to estimate time walking from one station to the next.

**Table. Distribution of time (in minutes) individuals spend at each station**

	Time (in minutes)		
	Min	Mean	Max
Time in the Welcome Station	0.2	0.3	0.5
Walk from Welcome Station to Medical History and Paperwork Station			
non-ADA		0.25	
ADA		0.25	
Time in Medical History and Paperwork Station			
non-ADA	2.6	5.5	11.4
ADA	3.3	6.8	14.3
Walk from Medical History and Paperwork Station to Waiting Room			
non-ADA		0.17	
ADA		0.17	
Time in Waiting Room Station	0.05	0.15	0.3
Walk from Waiting room to Vaccination Station			
non-ADA		0.17	
ADA		0.17	
Time in Vaccination Station			
non-ADA	1.2	3.6	7.6
ADA	1.5	4.5	9.5
Walk from Vaccination Station to Observation Room			
non-ADA		0.25	
ADA		0.08	
Observation Station			
non-ADA	3.9	11.4	22.0
ADA	4.2	14.2	27.7
Walk from Observation Room to Exit			
non-ADA		0.17	
ADA		0.25	

*Source: observational data from large-scale vaccination clinics that anonymously recorded patients' overall time, and time at each clinic station.*