FluVacEcon

Software to estimate the economics of annual influenza vaccination from the perspective of the health care system

FluVacEcon 1.0 Beta Test Version

CDC

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ACKNOWLEDGMENTS

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SUGGESTED CITATION:
Meltzer MI. FluVacEcon 1.0: Manual to assist public health officials the economics of annual influenza vaccination (Beta test version). Centers for Disease Control and Prevention, U.S. Department of Health and Human Services; 2006.

THANKS
I thank Dr. Praveen Dhankhar for his invaluable help with coding FluVacEcon with the Visual Basic command buttons and help windows.

COVER PHOTO:
Influenza virus photo on the cover is an electron micrograph magnified 150,000 times over normal size. I thank Dr. Nancy J. Cox, Director, Influenza Division, CDC, for providing this photo.

DATE of this draft: August 16, 2006

DISCLAIMERS

The numbers generated through FluVacEcon are not to be considered absolute forecasts of the cost-effectiveness of routine (annual) influenza vaccinations. Rather, they should be treated as estimates with degrees of uncertainty (which may or may not be known).

The methodology, findings and conclusions in this manual, any accompanying appendices and results generated by the software (FluVacEcon) are those of the author and do not necessarily represent the views of the author's sponsoring agency.

This version is a beta test version. As such it has not been officially cleared.

DEFAULT DATA

This version of FluVacEcon contains data that are purely illustrative. Users are strongly encouraged to enter data relevant to the situation that they are studying.

SYSTEM REQUIREMENTS

FluVacEcon uses the Windows* operating system (Microsoft Windows 2000 or higher) and Excel (Microsoft Office 2000 or higher). We recommend using a computer with at least a 486 Pentium processor and at least 128MB RAM. FluVacEcon requires up to 2 megabytes of storage space on the computer's hard drive.

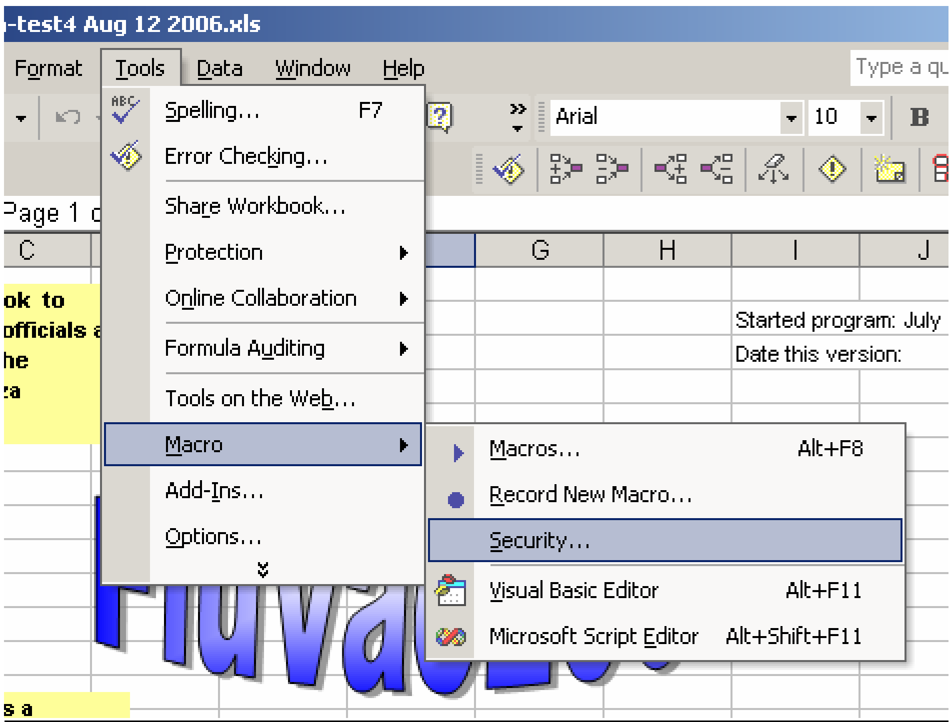
*Microsoft Windows and Office are copyrighted products produced by Microsoft Corporation, WA. Use of trade names and commercial sources is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services.

LOAD AND START

Before loading and starting FluVacEcon, you must make sure Excel's security level is set appropriately. ***You must first do the following steps:***

1). Open a blank Excel spreadsheet.

2). Click Tools and then click Macro, choose Security.



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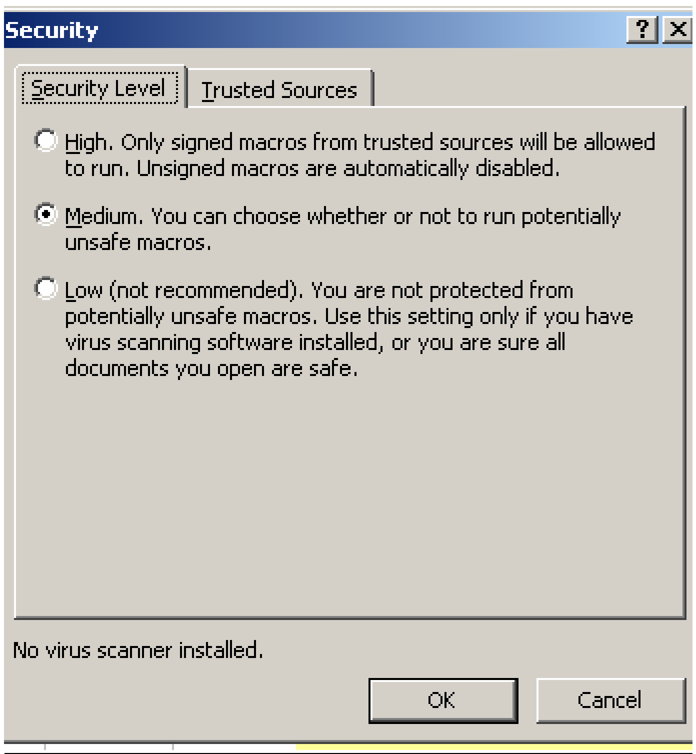
3). In the “pop-up” box that will appear see below), set Security Level to Medium.

4). Click OK.

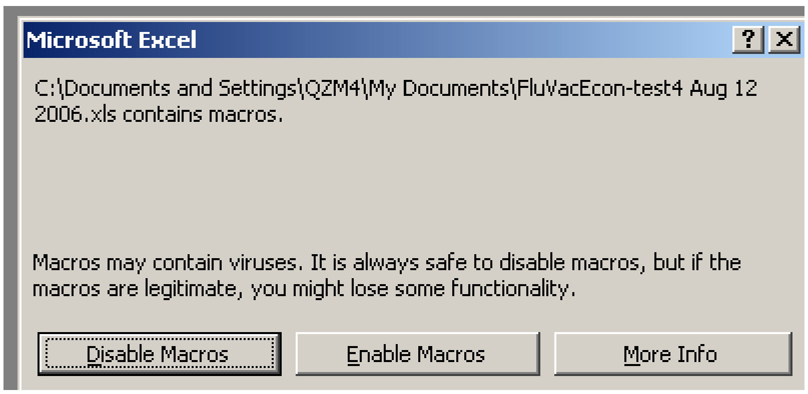


4). Click OK.

(Continued on next page).

5). Go to the drive/ location where you have saved the copy of FluVacEcon (e.g. C; Drive). Double click on the file, which will open FluVacEcon.

6). As the computer is loading Excel (if it is not already loaded) and FluVacEcon, a window will pop-up (see figure below), asking you if you want to Disable Macros or Enable Macros. Select/ click Enable Macros. FluVacEcon will then fully load, and you will be ready to start.



INTRODUCTION

Estimating the economics of routine (i.e., annual) influenza vaccination requires combining four types of data. First, we need data recording who becomes clinically ill from influenza, and the consequences of such illnesses (i.e. epidemiological data). We also need data that measure the effectiveness of influenza vaccine. We also need cost data recording the cost of treating patients who become ill and receive medical care, and, finally, we need data recording the cost of vaccination (and not just the cost of the vaccine in a vial).

The methodological concepts that are embedded in FluVacEcon, therefore, focus on how to combine these four data elements in as simple a manner as possible, but still provide as realistic a “picture’ of the cost-effectiveness of influenza vaccination.

BACKGROUND TO METHODOLOGY: TWO GUIDING PRINCIPLES

First guiding principle: Include variability of input data: A model for calculating cost-effectiveness of influenza vaccination must allow for the variability in the four types of data used.

The methodology of combining these four types of data must allow for the fact that, biologically, the impact of influenza varies greatly from year-to-year (or, season-to-season). Further, the methodology must explicitly include allowances for the variability of the effectiveness of influenza vaccine and the inevitable variable in costs (both of treating influenza-related illnesses and influenza vaccination). Thus, the methodology used in FluVacEcon explicitly and deliberately allows for simultaneous variability in most of the input variables.

The mathematical principles used in the construction of FluVacEcon are similar to those used in Meltzer MI, Neuzil KM, Griffin MR, Fukuda K. An economic analysis of annual influenza vaccination of children. Vaccine 2005;23:1004-1014.

Second guiding principle: useful to intended audience: Any model/ software developed must be sufficiently simple so that the intended audience (practicing public health officials) can readily use it, and readily interpret input and output values. The intended audience must be able to use the software without using specialized software, programming skills or having advanced knowledge of statistics.

In the Meltzer et al paper (2005), in order to allow for the variability in input data (i.e., incorporate the first guiding principle), we used a Monte Carlo methodology. That methodology samples probability distributions of input values (i.e., mathematically incorporates/ allows for variability of input values). However, Monte Carlo methodology requires a great deal of data (to construct “reasonable” probability distributions of input values), as well as ownership and understanding of specialist statistical software.

In this software, in order to satisfy both guiding principles, instead of using Monte Carlo sampling methodology, I used a "bootstrap" methodology. This methodology re-samples several hundred times a small dataset of input values (e.g., 5 data points) to build a larger data set. From this larger dataset, I can build a probability distribution of input data values (see Methods section for further technical details). This building of a probability distribution of input values, even when the input dataset is small, allows for variability in input values. Further, the re-sampling automatically is programmed into the spreadsheets, and the user does not have own specialized statistical software. Thus, this methodological approach of "bootstrapping" meets the two principles guiding the design of the FluVacEcon.

METHODS

FluVacEcon is written (constructed) in Microsoft Excel/Visual Basic.

Equation: Non-fatal outcomes (e.g., outpatient visits and/ or hospitalizations): The cost-effectiveness ratio in the model/ software is calculated as follows:

Equation (1):

$$\text{\$/ case averted} = \frac{\text{Cost of vaccination program} - (\text{Cases averted X \$ treating a case})}{\text{Cases averted}}$$

Where:

Cases averted = Rate of cases (per unit population) X population (per unit population) X vaccine effectiveness

Cost of vaccination program = Total cost to vaccinate one person X population X percentage compliance

"case" here could be an outpatient only, a hospitalized patient only or a combination of both.

"population" here refers to a given age and risk group, defined by the user, that is the focus of an analysis done using FluVacEcon (see also Methods: Page 2 of 10, below).

"per unit population" refers to the standardized unit used to measure the health outcome(s). For example, number of outpatient visits per 10,000 population. When using equation (1) FluVacEcon is coded to automatically adjust the population to the same unit used to measure rates.

Equation: Deaths: The cost-effectiveness ratio in the model/ software is calculated as follows:

Equation (2):

$$\text{\$/ death averted} = \frac{\text{Cost of vaccination program} - (\text{Cases averted X \$ treating a case})}{\text{deaths averted}}$$

Where:

Cases averted = Rate of cases (per unit population) X population (per unit population) X vaccine effectiveness

Cost of vaccination program = Total cost to vaccinate one person X population X percentage compliance

Study perspective: FluVacEcon calculates the cost-effectiveness ratios, using the equations outlined above, from the perspective of the health care system. That is, how much will the health care system pay for vaccinating a target population, how much will the health care system save from such a vaccination strategy, and what will be the net cost (or savings) per case (or death) averted).

This perspective was chosen because the intended audience is practicing public health officials, working in countries (e.g., member states of the Pan-American Health Organization (PAHO)) that typically have centralized, government funded, health care systems.

Broader societal considerations, such as work days lost to influenza, and gained/ saved due to influenza vaccination, are not considered under this perspective.

Discount rate and time horizon considered: Influenza virus constantly mutates, creating new strains, some of which are capable of infecting populations each and every year. Thus, a given country or community faces a new influenza season every year, and those targeted to receive influenza vaccination must be vaccinated each and every year (i.e., last years influenza vaccination will not protect a person from this years influenza strain). Thus, the effective duration of protection afforded by an influenza vaccination is one year (or season).

FluVacEcon, therefore, takes a time horizon of 1 year, for both interventions and benefits. There is no need to extrapolate forward either costs or benefits from vaccination. Thus, neither costs nor benefits are discounted.

METHODS: DATA INPUT

HOW TO ENTER DATA

In FluVacEcon, data should only be entered in the boxes/ cells outline with bold black borders.

DATA TO BE ENTERED

Page 2 of 10

Population being considered for vaccination

Age group in years: User enter, in years the age group of the population being studied.

Risk group: User enters/ selects one of three choices: High Risk (HR) group, non-High Risk (non-HR), or combined (HR + non HR, mixed).

Risk group here is defined as those persons with certain pre-existing medical conditions, such as diabetes, asthma, emphysema, other heart and lung conditions, pregnancy, etc., etc. (for additional details, see Centers for Disease Control and Prevention. Prevention and Control of Influenza: Recommendations of the Advisory Committee on Immunization Practices (ACIP) MMWR 2006;55(No. RR-#10): 1-48).

Percentage High Risk: This refers to the percent of High Risk (HR) person in the population studied. There must be some correlation between what is entered here and in the previous box (Risk Group). That is, if the user enters High Risk only, then in this box, the user will enter 100%. If the user enters in the previous box non-High Risk only, in this box the user will enter 0%. If the user is studying a mixed risk group, the user enters the estimates/ assumed percentage of high risk persons in the population being studied.

Number in target pop. (population): Enter the number in the population being studied. An exact number is not really required.

Study perspective: The only perspective that FluVacEcon uses is that of the health care system (see earlier).

DATA TO BE ENTERED

Page 3 of 10

Rates of non-death influenza-related health outcomes

Background: The data entered in this page records the rates of influenza-related health outcomes, such as outpatient visits and inpatient stays (hospitalizations).

Type of influenza health outcome: The user indicates/ selects the type of non-fatal health outcome data that will be used in the analysis (see figure below). The user must enter 'yes' (without the quotation marks) in one (and only) one of the three boxes. In the other two boxes, the user must enter 'n/a' (without the quotation marks).

	Select one, by entering "Yes" , and "N/A" for others				
Type of influenza health outcome	Combined in and outpatients		Outpatient only		Inpatient only
	yes		n/a		n/a
Check selection	Selection of type of rate data "OKAY" - please proceed				

Combined inpatient and outpatient data: FluVacEcon can "accept" data that combines the rates of outpatient and inpatient influenza-related health outcomes. For example, a rate of outpatient visits of 550 per 100,000 + a rate of hospitalizations of 10 per 100,000 gives a combined rate of 560 health outcomes per 100,000.

Note that, in order to combine outcomes correctly, the user must first ensure that both rates are recorded in the same measure of unit population (e.g., both rates record per 100,000 population, or whatever is the most convenient rate).

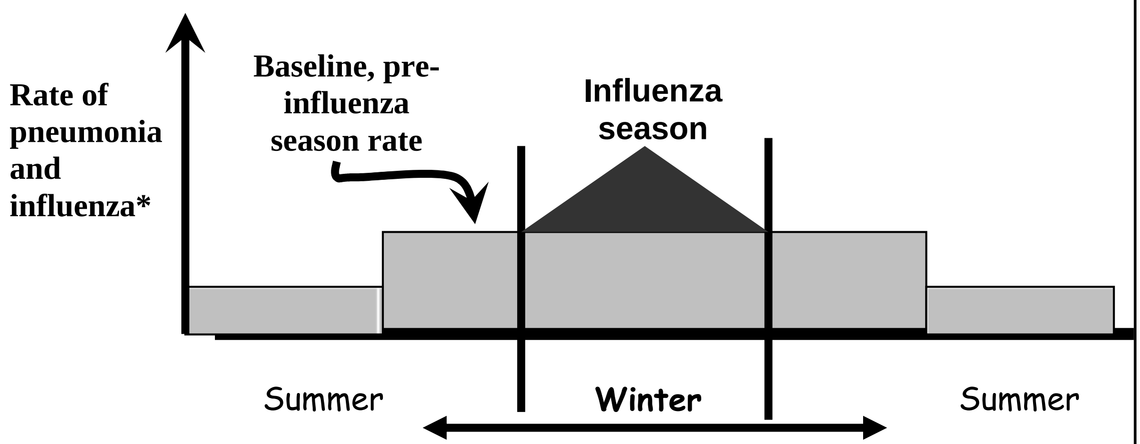
Unit of rate: Record here the unit of rate for the data that will be entered (e.g., per 100,000 population being studied).

Type of rate: Excess rates: Due to a variety of reasons, it is rare to find data that accurately measures the number of influenza-related outcomes (e.g, visits to a clinic, inpatient admissions). A detailed description of how to measure influenza-related visits to health care facilities is beyond the scope of this manual, but a brief description follows.

In almost all instances, the number and rate of influenza-related outcomes have to be retrospectively estimated. This typically requires using databases (e.g., hospital records, health system payment data) that record the number of visits by codes that are used to record the for each visit (the codes are called International Classification Codes, version 9 or 10, ICD-9 or ICD-10). These codes are usually not specific.

Due to the inherent inaccuracy of ICD codes, an analyst trying to measure the rate of influenza-associated healthcare visits or hospitalizations typically has to first determine when the influenza season starts. Then the analyst will use the ICD codes to measure the average rate of visits before the influenza season, during the influenza season and after the season is over. The difference between the before and during is then termed "excess" rate, and this excess number of visits (or rate of visits) is assumed to be primarily due to influenza (see schematic below).

Figure: Schematic illustrating the calculation of excess influenza-related rate of health outcomes



* Note: Rate could be for other categories, such as cardiac and respiratory diseases,

A key element of this methodology is determining when an influenza season starts. Analysts can, for example, use information from influenza virus surveillance, which measures the percent of nasal swabs that test positive for influenza. Once the percentage of influenza-positive samples reaches some pre-determined threshold (e.g., 10% of samples test positive for influenza), an analyst will then assume that the influenza season has 'started.' There are also a number of statistical methodologies that consider seasonal patterns in the health care visit data, and (again) whenever the number of visits exceed some predetermined threshold (e.g., two standard deviations above the mean number of visits), then the analysts assumes that an influenza-related epidemic has occurred. Currently, there are no studies that have evaluated which method is best. Each method has "pros" and "cons."

For FluVacEcon, a user must record what type of methodology was used to calculate the influenza associated rate of health outcomes entered into this study.

(Instructions for Page 3 of 10 continued)

DATA (RATES): In these cells, a user enters the actual data, in the form of rates per unit population (the unit having already being recorded – see "Unit of rate," above).

RULES FOR DATA ENTRY:

i) Rates must ONLY record health care visits for influenza-related illnesses. Recording, for example, all visits for pneumonia and influenza without first calculating the excess number of such visit due only to influenza will, result in erroneous estimates of cost-effectiveness. If you do not enter visits calculated to be due only to influenza, you will over estimate pact of influenza and thus over-estimate potential benefits that may be derived from vaccination.
ii) For FluVacEcon to calculate correctly, you need to enter a minimum data for 5 contiguous years/ seasons.
iii) Enter "N/A" for each season for which there are no data (remembering that you must enter a minimum of 5 years of data – see Rule ii).
iv)Years/ seasons entered here must match years/seasons entered into "Deaths" input sheet.

FluVacEcon: Calculating probabilities from the available data:

It was assumed, when constructing FluVacEcon, that many users will not have, readily available, a great deal of data recording the excess rates of influenza-related visits to health care facilities. However, biologically, influenza is a disease whose impact varies greatly from year-to-year. A simple descriptive statistic, such as the "average" rate of excess health outcome, is often misleading. A single "bad" influenza season, causing "above normal" number of visits to the health care facilities can greatly increase the estimate of the average health outcomes. Similarly, the estimate of average could be influenced by the inclusion of one or two seasons which are atypical and "usually mild." Thus, if a user has only five years worth of data (or even 10 years), the calculated average cost-effectiveness ratio can vary greatly, depending on which 5 years are measured.

Conclusion: Having only 5 – 10 years worth of data will most likely create an inaccurate probability distribution describing the rates of health outcome (i.e., the small data sets that are likely to be available will not reliably record the probability of a given rate of health outcome occurring)

Thus, in order to reduce potential biases in probabilities caused by having only 5 – 10 years of data, FluVacEcon uses a statistical technique called "bootstrapping" to "amplify" the number of measurements available to record the probability of health outcome rates occurring.

In FluVacEcon, the program randomly selects/ samples four seasons/ years worth of data. FluVacEcon uses a system of sampling called "sampling with replacement," which means that it is possible (but very unlikely) that a single season will be selected 4 times. It then calculates the average for those seasons, and places that average in a separate column. FluVacEcon does this random sampling 300 times. The result is a column of 300 averages. With 300 data points, FluVacEcon then calculates the cumulative probability distribution of the excess health outcome rates, including the 5^{th} and 95^{th}, percentiles, the median, average, minimum and maximum values.

The “pros” of such a system is that it “amplifies” small sets of data and provides a more stable probability distribution.

The “cons” of such a system is that the technique ignores possible biologically important factors that may determine the actual, “real life” probability distribution. For example, in a given year, the rate of health outcomes may have been influenced by the rate in the previous year(s). The degree of such year-to-year correlation and influence is unknown, and thus it is unknown how important it is to have such year-to-year correlation included in the construction of a “bootstrapped” probability distribution.

DATA TO BE ENTERED

Page 4 of 10

Rates of deaths due to influenza

This data entry page is the same in concept, and has the same elements, as Page 3 of 10 (Rates of non-death influenza-related health outcomes). The explanation of each of the data entry elements required is the same as for Page 3 of 10, with the difference that in this data-entry page, the rates entered must measure the excess rate of deaths due to influenza.

DATA TO BE ENTERED

Page 5 of 10

Cost per person treated: In and outpatients

NOTE: Costs are marked in "$" terms. However, the user can enter cost data in any currency desired. The only rule is that all cost data must be entered in the same currency.

Outpatient $: This column of data records the cost of an outpatient visit for influenza-related illness.

The categories in this column ($/visit, $/drugs, $/other) are suggested cost elements that analysts and policy makers may be interested in recording.

However, there is no absolute set rule as to what should be recorded in this column. Technically, what is needed is a number recording the cost to the health care system (the perspective of FluVacEcon – see earlier) of treating an outpatient for influenza. Such estimates should follow "good accounting practices, and record all expenditures of delivering appropriate treatment to a patient. Such costs would include physician and nurse time (salary and wages), tem for any clinic administrators, supplies and lab tests, overhead to operate clinic (e.g., utilities, building repairs and maintainer, et., etc.).

The detail entered into FluVacEcon is dependent upon the user. It may well be, for example, that a FluVacEcon user can readily obtain an estimate of total cost, but not a breakdown of costs. In that case, the user would simply enter the total cost in the cell "**$/visit,"** and leave the other cells in the column as "$0."

A user may, for example, find it easier to estimate cost of a health care visits in a separate sheet and just enter the sum total (in the "$/visit" cell).

Inpatient $: This column records all the costs of treating an inpatient for influenza-related illnesses.

As in the outpatient cost column, there is no absolute set rule as to what should be recorded in this inpatient cost column. Technically, what is needed is a number recording the cost to the health care system (the perspective of FluVacEcon – see earlier) of treating an inpatient for influenza.

The detail entered into FluVacEcon is dependent upon the user. It may well be, for example, that a FluVacEcon user can readily obtain an estimate of total cost, but not a breakdown of costs. In that case, the user would simply enter the total cost in the cell "**$/day bed,"** and leave the other cells in the column as "$0."

 # outpatient visits: It is realistic to assume that an inpatient may also have had an outpatient visits before and possibly after (for follow-up) an inpatient stay. However, the user must ensure that, if a number of outpatient visits associated with an inpatient stay are entered in this column, then those outpatient visits are REMOVED from the rate of outpatient data (Page 3 of 10).

In many instances, it is likely that a user will not be able to identify which outpatient visits (if any) are associated with an inpatient stay. In such situations, in order to avoid any double accounting, the user MUST enter '0" visits in the "# outpatient visits" in this column of costs for inpatients.

# of outpatients per inpatient: If, in data entry Page 3 of 10 (Rates of non-death influenza-related health outcomes), you entered combined outpatient and inpatient data, then you MUST enter the approximate number of outpatients per inpatient.

DATA TO BE ENTERED

Page 6 of 10

Effectiveness of influenza vaccine

In this page a FluVacEcon user enters the assume probabilities of vaccine effectiveness. It is a fact that, due to the method to identifying influenza strains used in the vaccine, the effectiveness of influenza vaccines is not necessarily stable from year-to-year. Indeed approximately once every eight to ten years, there is a “mismatch” between the strains used to produce the vaccine and most common circulating strains. This mismatch can lead to much lower than usual levels of vaccine effectiveness.

ENTER Assumed probabilities: For each level of stated vaccine effectiveness (e.g., 20%), the FluVacEcon user an assumed probability. For example, for 20% effectiveness, the user enters a probability of 0.005 (0.5% or one-half of one percent).

WARNING: The entered probabilities must total (add-up) to 1.000 (or 100%). FluVacEcon displays the total of all probabilities at the bottom of the column.

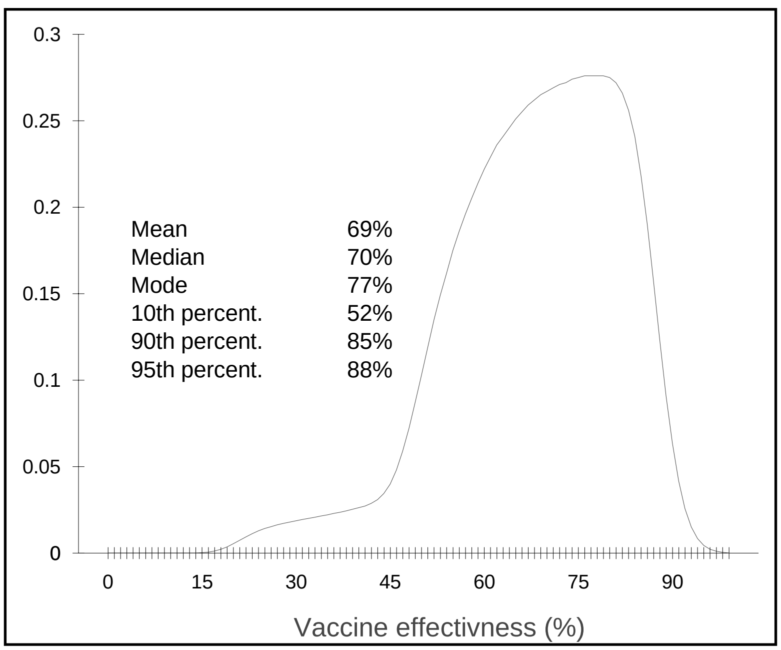
What does FluVacEcon do with the data? FluVacEcon calculates the probability-weighted average vaccine effectiveness. This is calculated as follows: Average vaccine effectiveness = Sum of all (probability of a given level of effectiveness X level of effectiveness).

Limitations of methodology: The current methodology used in FluVacEcon to evaluate all the user-entered data concerning vaccine effectiveness is simple and direct. However, if does not necessarily fully utilize all the data contained in the probability distribution. Future versions of FluVacEcon may contain a more sophisticated methodology for incorporating the vaccine effectiveness data.

Another limitation is that vaccine effectiveness was assumed to be identical for all outcomes.

Data source: The default vaccine effectiveness probabilities contained in FluVacEcon are based on those assumed in Meltzer et al. (Vaccine 2005;23:1004-1014) (see figure below). Meltzer et al. constructed the probability distribution as follows: ". . . used standard software (RiskView and BestFit, Palisade Corp., Newfield, NY) to construct a vaccine effectiveness probability distribution that had the following characteristics: most probable vaccine effectiveness against influenza of 70–80%, with a 10% chance of effectiveness being less than 50%. Maximum effectiveness set at 98%, with the 95th percentile of effectiveness set at approximately 90%. Vaccine effectiveness was assumed to be identical for all outcomes and to last for only one influenza season."

Figure: Illustration of assumed vaccine effectiveness probability distribution



Source: Meltzer et al. Vaccine 2005; 23:1004-1014

DATA TO BE ENTERED

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Cost per person vaccinated

$/ person vaccinated: Lower & Upper: In these two columns, the FluVacEcon user enters upper and lower estimates of the cost of vaccinating one person against influenza.

The guiding principle in this data entry sheet is that the cost of vaccinating a person is a great deal more than just the cost of the vaccine. Indeed, delivering the vaccine to the clinic, and assembling all the elements to administer that vaccine (physician and nurse time, syringes, clinic overhead, etc., etc.) may be more costly than the actual purchase of the vaccine.

As in the other cost data entry pages (Page 5 of 10), the categories in this column (vaccine physician, nurse, etc., etc.) are suggested cost elements that analysts and policy makers may be interested in recording. Again, if a user only has, at least initially, a total estimate, that incorporates all the costs without a breakdown, the user can merely enter that total cost in the row labeled "Vaccine," and enter $0 for all other elements.

WHY two columns – "Lower" and "Upper"? Lower and upper estimates do not necessarily have to represent minimum an maximum range of potential cost. However, it is realistic to assume that, over time and by locale, costs will likely vary. This potential for variability must be explicitly modeled.

Side effects: It is a fact that, no matter how rare, there are adverse events associated with influenza vaccination (i.e., patients can experience harmful side effects). The vast majority of recorded side effects tend to be of a "minor nature," such as soreness at the site of vaccination. However, some side effects can be serious and, very rarely, life threatening. Such serious side effects require medical attention and therefore represent a cost associated with vaccinating a patient.

The costs associated with treating these serious side effects, no matter how rare, should be explicitly accounted for.

In this page, three types of serious side effects are accounted for: anaphylaxis, Guillain-Barre Syndrome (GBS), mild. For each side-effect, the user enters the probability of such a side effect (in column "Probability") and the cost of treating one case of that side effect (in column "$ treat"). FluVacEcon then calculates the average cost=per=person vaccinated for treating each type of side effect, as follows; Cost per person vaccinated for treating side effect = probability of side effect x $ treating person with side effect. FluVacEcon then sums up the three costs (per person vaccinated) and this sub-total is then automatically entered into the columns totaling cost per person vaccinated (both lower and upper estimate columns receive the same estimate for treating side effects).

Percentage persons requiring two doses: Certain age groups, particularly the very young (e.g., infants) require two disease of influenza vaccine the very first time that they are vaccinated. In subsequent seasons, they require only one dose. The user enters the estimates percentage of the target population (identified on Page 2 of 10) that need two doses. The range of possible entry values is from 0% to 100%.

Assumed compliance: Enter the assumed percentage of persons in the target population (identified on Page 2 of 10) that will be successfully vaccinated against influenza in a given year. The range of possible entry values is from 0% to 100%.

RESULTS

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Results: Summary of the health outcome data entered into the model

This page summarizes the input data contained in Pages 2, 3 and 4. These graphs are provided so that a FluVacEcon user has a convenient method of displaying some of the critical input data. These graphs can be copied and pasted into presentations and reports.

RESULTS

Page 9 of 10

Results: Net $/ case or death averted

This page provides two graphs depicting the cost-effectiveness of annually vaccinating persons in the target group (defined on Page 2 of 10) against influenza.

The equations used to calculate the data depicted in these graphs are provided earlier in this manual (Methods: page 8).

The graph on the left depicts to cost-per case averted, where a case may be inpatient (only), outpatient (only) or combined (inpatient + outpatient). The definition of what type of case is depicted in the graph depends upon the data entered in Page 2 of 10.

The graph on the right depicts the cost-per-death averted.

What do these results "mean?"
On the X-axis, along the bottom of each graph, is a range of $/ person vaccinated. This range encompasses the range of costs of vaccinating a person entered by the user on Data Entry Page (note that if the user changes the range of costs in Data Entry Page 7 of 10, the range in the graph may change). On the y-axis is the cost-effectiveness ratio, either "$/case averted" (left hand graph), or "$/ death averted" (right hand graph). The solid line in each graph indicates the median cost-effectiveness ratio, whilst the two dotted lines represent the 5^{th} and 95^{th} confidence intervals.

In each graph, any time any results (a line, or part of a line) are above the $0/ case averted or $0/death averted, that means that influenza vaccination results in a net cost to the health care system. In order for there to be a net savings (per case or death averted) to the health care system, the line must be below the $0/ case averted (i.e., read as -$/ case averted).

 # persons vaccinated: Records the number of persons assumed vaccinated (entered by user in Page 2 of 10).

Total $ of vaccination effort (1 year): Shows the estimated (lower and upper) costs of vaccinated the target population. These estimates are calculated as follows: Cost of vaccination campaign (1 year) = cost of vaccinating 1 person X number of persons vaccinated. The costs of vaccinating 1 person are derived from Data Entry Page 7 of 10.

Additional results: By scrolling down below the graphs, the user will find two tables in which additional, more detailed results of the cost-effectiveness analyses can be found. Each table provides, from the 5^{th} to 95^{th} percentile, the number of cases (deaths) averted, the costs saved by the health care system (before considering costs of vaccination), and the cost-effectiveness ratios, expressed in terms of the lower and upper limits of the cost of vaccination (as defined in DATA Entry Page 7 of 10).

RESULTS

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Results: Sensitivity analyses

Built-in sensitivity analyses: As already discussed (for DATA Entry for Page 3 of 10, see earlier), to compensate for small data sets recording influenza-related health outcomes, FluVacEcon is programmed to repeatedly sample (300 times) the small set of the recorded health outcome rates, producing a large number of possible average health outcomes. This built in methodology is a form of sensitivity analysis. Further, the model allows a user to make a ready and rapid examination of the impact of changes in most of the input variables. For example, the user can readily make changes in vaccination costs, rates of health outcomes, vaccine effectiveness, population under study (by age, risk groups, size, etc.), as well as changes in cost of vaccination.

What sensitivity analyses can a user do? The user is encouraged to extensively explore the impact of making many changes in input values, and is particularly encouraged to make several changes at the same time to different variables (this is called "multi-variable sensitivity analyses"). A user can produce any number of multi-variable sensitivity results by collecting the results, produced by each new combination of input values, from the detailed results tables in the "Results" sheet (scroll down below the results graphs).

Example: The sensitivity analyses graph on Page 10 of 10: On Page 10 of 10, there is an example of a graph produced by running FluVacEcon several times. This graph illustrates how step-wise changes in vaccine effectiveness impacts the cost-effectiveness ratio for two different costs of vaccination. Essentially the graph illustrates how fixed increases in vaccine effectiveness can reduce the cost-effectiveness ratio (i.e, $/ case averted becomes less costly as vaccine effectiveness increases).

The graph contains 3 different types of data: i) two costs of vaccination; ii) range of vaccine effectiveness; and, iii) resultant cost-effectiveness ratios. The data for the graph were obtained by first fixing the weighted average vaccine effectiveness on Data Entry Page 6 of 10, and the recording the resultant median (50^{th} percentile) cost effectiveness ratios from the detailed tables of results (Results page 9 of 10). The process is repeated a number of times, each time entering a different estimate of vaccine effectiveness. Note that, in order to keep the graph “clean and simple,” I have chosen to omit any confidence intervals (i.e., the 5^{th} and 95^{th} percentiles are not drawn in - but they could be added if the user so wishes).

Interpreting the results: determining which variables are most influential: By looking at the graph in the sensitivity analysis page (Page 10 of 10), and the graphs in the results page (Page 9 of 10), a user can begin to see which variables (within the range of values examined) are most influential. For example, in the sensitivity analysis (drawn from results produced using the illustrative data) on Page 10 of 10, we note that if a user approximately doubles the cost of vaccination, then the cost effectiveness ratio also approximately doubles. But, as vaccine effectiveness increases from 50% to 90% (an 80% increase), we note that the cost-effectiveness ratio only decreases by approximately 45% (fro the $11.06/ person vaccinated, at 50% vaccine effectiveness, cost-effectiveness is $21,750/ case averted. At 90% effectiveness, cost-effectiveness is $12,004/ case averted).

Thus, a user can conclude that the results, derived from the illustrative default data, are more sensitive to changes in the cost of vaccination than changes in vaccine effectiveness. That is, in terms of cost-effectiveness (and within the range of values examined), cost of vaccination is more influential than vaccine effectiveness. Of course, entering in other data may change that conclusion.

COPYING AND PRINTING

Copying: Any Page, Table or Graph in FluVacEcon can be copied and pasted to another Excel-compatible program application (e.g., for presentations or report writing), using standard procedures.

Most of the time, a page or table or graph can be copied and pasted by first selecting the area/ graph needed to be copied, right clicking on the mouse to produce a menu and selecting “copy” from the menu.

The copied object can then be pasted in the new application as need (by clicking the right button in the mouse, and then selecting “Paste”). For more information, please consult Excel’s online help or a manual for Excel.

Printing: In order to print your results on a single page, you may need to change the printing page setup to Landscape format. To do so,

1). Click File and then choose Page Setup.

2). In the Orientation section, change Portrait to Landscape.

3). Click OK.

CONTACT

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