COSTS AND EFFECTIVENESS OF IMMUNIZATION PROGRAMS

I. INTRODUCTION

A. Immunization lends itself well to the assessment of effectiveness

1. Link between input, output, effect and impact is reasonably well understood

2. Many publications are available to guide the cost analysis
   a. Typically emphasize using economic appraisal as a means for...
      (1) assessing the efficiency of existing immunization delivery
      (2) determining the choice of strategies for expanding coverage

B. Use immunization program models that link cost to health outcomes

1. Encourages the decision-maker to...
   a. establish relationships between cost, program efforts and disease outcomes
      (1) Use existing knowledge of financial systems
      (2) Use biomedical knowledge
   b. rationally discuss merits of various program alternatives
      (1) Analytic rather than a political
   c. estimate the magnitude of the various parameters in the model
      (1) Determine necessary information for future surveys, etc.

2. Use to test assumptions and see how changes affect the outcomes
   a. Least costly way to do experiments

C. Cost-effectiveness models for microcomputers

1. "What if" analyses
   a. Sensitivity analysis
      (1) Determine how sensitive the outcome of interest is to varying values of input parameters.
   b. Spreadsheet programs such as Excel or Quattro

2. Present the results in graphic form
   a. Easier to observe the main trends or patterns
3. Guides rather than directs program planner or policy-maker
   a. Seeing resultants on the computer monitor is often more convincing than having a "heated" political discussion
   b. Promotes self-learning rather than having to rely on the opinions or interpretations of staff members
      (1) Spreadsheet models are easy to work with, once they have been correctly set up by the technical staff

II. ESTABLISHING COSTS

A. Problem areas

1. Proportion of variable and fixed costs to be attributed to the immunization program
   a. Problem in multi-purpose programs where health personnel doing many different tasks
   b. Variable (or operating) costs
      (1) Costs that vary with the number of administered vaccine doses
         (a) Clinics immunizing 500 children per year have a lower operating cost than clinics immunizing 1,000 children per year
   c. Fixed costs
      (1) Costs that do not vary with the number of administered vaccine doses
         (a) Tend to remain fixed for an entire year
         (b) Clinics immunizing 500 children per year may have the same fixed cost as clinics immunizing 1,000 children per year

2. Need to correct for distorted or inappropriate domestic market prices
   a. Establish shadow prices to more realistically deal with subsidized vaccine production costs
      (1) Price set by economists to reflect the true value to society of an item or program when not traded in a free market
         (a) True cost of establishing and operating the program elsewhere
   b. Include cost of donations from outside agencies

B. Budget categories

1. Personnel
   a. Salaries of supervisors, immunization team and support staff
   b. Both variable and fixed costs

2. Facilities
   a. Buildings such as hospitals or rural health centers
   b. Fixed costs
3. Materials and equipment

a. Vaccines, furnishings, etc.
b. Both variable and fixed costs

4. Miscellaneous

a. Vehicles and fuel for vehicles
b. Other unclassified items
c. Both variable and fixed costs

5. Patient inputs

a. Transportation and food costs for those accompanying the patient
b. Variable costs

III. ESTABLISHING THE LEVEL OF EFFECTIVENESS

A. Need to create a single outcome measure

1. Measures of output

a. Number of administered vaccine doses
b. Number of fully vaccinated children

(1) Developed country example (USA)
   (a) *MMWR* 57 (01), Q1-Q4, Jan. 11, 2008.

(2) Developing country example (8 doses)
   (a) DPT - 3 doses per child
   (b) OPV - 3 doses per child
   (c) BCG - 1 dose per child
   (d) Measles - 1 dose per child

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**Figure 1.** Recommended young child (0-6 years) immunization schedule, United States 2008.
2. Measure of effect

   a. Number of children with four-fold increases in immune titer
      (1) Based on serological evidence (paired sera)

3. Measures of impact

   a. Prevented morbidity
      (1) Cases
      (2) Rates (cases per unit population per time period of interest)
   b. Prevented mortality
      (1) Deaths
      (2) Rates (deaths per unit population per time period of interest)
   c. Reduction in days of healthy life lost (DHLL)
      (1) Days (or years) of healthy life gained (DHLG or YHLG)
      (2) Rates (annual DHLL, DHLG or YHLG per 1,000 population)
   d. Reduction in disability-adjusted life years (DALYs) lost
      (1) Not covered in this lecture, but extension of DHLL concept

B. Derivations

1. Number of prevented cases

   a. Required data
      (1) Annual number of vaccinated children
         (a) Count tally sheets of immunization clinic or program
         (b) Estimate indirectly

      Number of vaccinated children per year = Total population x Crude birth rate x \left[1 - \text{Neonatal mortality rate} \right] x Proportion of children vaccinated

      estimates the number of children, aged 0-1 year, available for immunization

      * measured as a proportion

      (2) Background incidence with no vaccination

      \[
      \begin{array}{c|c|c|c|c}
      \text{Vaccinated} & \text{Immune} & \text{Duration of immunity} & \text{Susceptible} \\
      \hline
      \text{Time} & \rightarrow & \\
      \hline
      \text{Unvaccinated} & \text{Susceptible} & \text{Expected cases during this time period per unit population} & \text{Susceptible} \\
      \end{array}
      \]

      Figure 2. Cumulative incidence among unvaccinated children during time of immunity.
(3) Vaccine effectiveness
   (a) Estimate based on prior studies
   (b) Conduct a field survey

b. Calculation

\[
\text{Number of prevented cases} = \text{Number of vaccinated children} \times \frac{\text{Background cumulative incidence}^*}{\text{during period of immunity}} \times \text{Vaccine effectiveness}^* \\
\text{expected cases during period of immunity if these children had not been immunized}
\]

* measured as a proportion

2. Number of prevented deaths

a. Required data
   (1) Number of prevented cases
      (a) Derived above
   (2) Case-fatality proportion
      (a) Proportion of deaths due to the disease among incident cases
      (b) Estimated from clinical experience
      (c) Derived in follow-up studies of incident cases

b. Calculation

\[
\text{Number of prevented deaths} = \text{Number of prevented cases} \times \text{Case-fatality proportion}
\]

3. Days of healthy life gained (DHLG)

a. Required data
   (1) Number of prevented cases
      (a) Derived above
   (2) Days of healthy life lost (DHLL) per case
      (a) See Ghana, 1981 reference article for details

b. Calculation

\[
\text{Days of healthy life gained} = \frac{\text{Number of prevented cases}}{\text{Days of healthy life lost per case}} \times \text{Days of healthy life lost per case}
\]

4. Years of healthy life gained (YHLG)

a. Calculation

\[
\text{Years of healthy life gained} = \frac{1}{365} \times \frac{\text{Number of prevented cases}}{\text{Days of healthy life lost per case}} \times \text{Days of healthy life lost per case}
\]
IV. ESTABLISHING THE LEVEL OF COST-EFFECTIVENESS

A. Need to link program cost with a measure of effectiveness

1. Derive **present value** for all future program costs so that comparisons can be made between one program and another

B. Measures relating *input* to *output*

1. Cost per vaccine dose

   a. Derivation

   
   \[
   \text{Annual cost per vaccine dose} = \frac{\text{Present value of average annual cost of vaccination program}}{\left( \frac{\text{Total population of children}}{} \times \text{Proportion of children vaccinated} \times \text{Average no. of vaccine doses given by program*} \right)}
   \]

   * usually up to 8 doses (3 of DPT, 3 of OPV, 1 of BCG and 1 of measles)

   (1) Assumes the cost per dose of vaccine is distributed equally among all doses of the vaccine

2. Cost per fully vaccinated child

   a. Calculation is specific to a vaccine

   (1) For DPT, fully vaccinated is 3 doses
       (a) If a total of 8 doses of vaccine are given by the program, the cost for DPT should be 3/8ths of the total cost

   (2) For OPV, fully vaccinated is 3 doses
       (a) The cost for OPV should be 3/8ths of the total cost

   (3) For BCG, fully vaccinated is 1 dose
       (a) The cost for BCG should be 1/8th of the total cost

   (4) For Measles, fully vaccinated is 1 dose
       (a) The cost for Measles should be 1/8th of the total cost

   b. Derivation

   
   \[
   \text{Annual cost per fully vaccinated child} = \frac{\left( \frac{\text{Number of doses for the specified vaccine*}}{\text{Average no. of vaccine doses given by program #}} \right)}{\left( \frac{\text{Total population of children}}{\text{Proportion of children vaccinated}} \right)}
   \]
* either 3 for DPT, 3 for OPV, 1 for BCG or 1 for measles  
# usually 8 doses

C. Measures relating input to effect

1. Cost per seroconverted case
   a. May be measured in the future with saliva

D. Measures relating input to impact

1. Cost per prevented case (vaccine-specific)
   a. Derivation

\[
\text{Annual cost per prevented case} = \left( \frac{\text{Number of doses for the specified vaccine} \times \text{Average no. of vaccine doses given by program #}}{\text{Present value of average annual cost of vaccination program}} \right) \times \left( \frac{\text{Number of prevented cases among the children vaccinated during a given year}}{\text{for DPT, includes prevented cases of diphtheria, pertussis and tetanus}} \right)
\]

* either 3 for DPT, 3 for OPV, 1 for BCG or 1 for measles  
# usually 8 doses  
@ for DPT, includes prevented cases of diphtheria, pertussis and tetanus
2. Cost per prevented case (disease-specific)

a. Derivation

\[
\text{Annual cost per prevented case} = \frac{\text{Number of vaccine doses for the specified disease} \times \text{Present value of average annual cost of vaccination program}}{\text{Average no. of vaccine doses given by program} \times \text{Number of shared diseases for the vaccine} \times \text{Number of prevented cases among the children vaccinated during a given year}}
\]

* either 3 for DPT, 3 for OPV, 1 for BCG or 1 for measles

# usually 8 doses

@ 3 for DPT and 1 for OPV, BCG and measles

¶ cases of either diphtheria, pertussis, tetanus, poliomyelitis, tuberculosis or measles

3. Cost per prevented death (vaccine-specific)

a. Derivation

\[
\text{Annual cost per prevented death} = \frac{\text{Number of doses for the specified vaccine} \times \text{Present value of average annual cost of vaccination program}}{\text{Average no. of vaccine doses given by program} \times \text{Number of prevented deaths among the children vaccinated during a given year}}
\]

* either 3 for DPT, 3 for OPV, 1 for BCG or 1 for measles

# usually 8 doses

@ for DPT, includes prevented deaths due to diphtheria, pertussis and tetanus

4. Cost per prevented death (disease-specific)

a. Derivation

\[
\text{Annual cost per prevented death} = \frac{\text{Number of vaccine doses for the specified disease} \times \text{Present value of average annual cost of vaccination program}}{\text{Average no. of vaccine doses given by program} \times \text{Number of shared diseases for the vaccine} \times \text{Number of prevented deaths among the children vaccinated during a given year}}
\]

* either 3 for DPT, 3 for OPV, 1 for BCG or 1 for measles

# usually 8 doses

@ 3 for DPT and 1 for OPV, BCG and measles

¶ deaths due to either diphtheria, pertussis, tetanus, poliomyelitis, tuberculosis or measles
5. Cost per day of healthy life gained (vaccine-specific)

a. Derivation

\[
\text{Annual cost per day of healthy life gained} = \left( \text{Number of doses for the specified vaccine} \times \text{Present value of average annual cost of vaccination program} \right) \times \left( \text{Average no. of vaccine doses given by program #} \times \text{Number of days of healthy life gained due to the prevention of the disease among children vaccinated during a given year} \right)
\]

* either 3 for DPT, 3 for OPV, 1 for BCG or 1 for measles
# usually 8 doses
@ for DPT, includes days of healthy life gained due to the prevention of diphtheria, pertussis and tetanus

6. Cost per day of healthy life gained (disease-specific)

a. Derivation

\[
\text{Annual cost per day of healthy life gained} = \left( \text{Number of doses for the specified vaccine} \times \text{Present value of average annual cost of vaccination program} \right) \times \left( \text{Average no. of vaccine doses given by program #} \times \text{Number of days of healthy life gained due to the prevention of the disease among children vaccinated during a given year} \right)
\]

* either 3 for DPT, 3 for OPV, 1 for BCG or 1 for measles
# usually 8 doses
@ for DPT and 1 for OPV, BCG and measles
¶ DHLG for either diphtheria, pertussis, tetanus, poliomyelitis, tuberculosis or measles

7. Cost per year of healthy life gained (vaccine-specific)

a. Derivation

\[
\text{Annual cost per year of healthy life gained} = 365 \times \left( \text{Number of doses for the specified vaccine} \times \text{Present value of average annual cost of vaccination program} \right) \times \left( \text{Average no. of vaccine doses given by program #} \times \text{Number of days of healthy life gained due to the prevention of the disease among children vaccinated during a given year} \right)
\]

* either 3 for DPT, 3 for OPV, 1 for BCG or 1 for measles
# usually 8 doses
@ for DPT, includes days of healthy life gained due to the prevention of diphtheria, pertussis and tetanus
8. Cost per year of healthy life gained (disease-specific)

a. Derivation

\[
\text{Annual cost per year of healthy life gained} = 365 \times \left( \frac{\text{Average no. of vaccine doses}}{\text{Number of shared diseases for the vaccine \#}} \times \frac{\text{Number of shared diseases for the vaccine \#}}{\text{Number of days of healthy life gained due to the prevention of the disease among children vaccinated during a given year \%}} \right) \times \text{Present value of average annual cost of vaccination program}
\]

* either 3 for DPT, 3 for OPV, 1 for BCG or 1 for measles

\# usually 8 doses

\@ 3 for DPT and 1 for OPV, BCG and measles

\% DHLG for either diphtheria, pertussis, tetanus, poliomyelitis, tuberculosis or measles

V. EXAMPLE USING EXCEL

A. Estimate the cost-effectiveness of childhood immunization programs for the child population in some specified service area

1. See Appendix for the complete set of 4 tables

B. Input data

1. Total population in service area

2. Crude birth rate in service area

3. Neonatal mortality rate in service area

4. Duration of program planning period (in years)

5. Annual discount rate for program costs

6. DHLL estimates

7. Expected duration of immunity due to the vaccine (in years)

8. Expected cumulative incidence among unvaccinated persons during the duration time of immunity

9. Proportion of the population which is vaccinated

10. Estimated vaccine effectiveness

11. Annual itemized costs
a. Personnel  
b. Facilities  
c. Materials and equipment  
d. Miscellaneous  
e. Patient inputs

C. Create the spreadsheet program (see Appendix for output)

1. Entries and formulas for top portion of the spreadsheet (above Table 1)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>COST-EFFECTIVENESS OF CHILDHOOD IMMUNIZATION PROGRAMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Total population in service area =</td>
<td>2,360,000</td>
<td>Neonatal mortality in service area</td>
<td>-</td>
<td>0.024</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Crude birth rate in service area =</td>
<td>0.032</td>
<td>Expected eligible child population in the service area per year</td>
<td>-B3<em>B5</em>(1-G3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Duration of program planning period (in years) =</td>
<td>5</td>
<td>Annual Discount Rate for Program Costs</td>
<td>-0.085</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Entries and formulas for Table 1 -- middle portion (see Appendix)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAYS OF HEALTHY LIFE LOST PER CASE</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>(B19<em>365</em>((B17-(B21-B15))+((B21-B15)<em>B23)))+(B25</em>B17<em>B27</em>365)+((1-B19-B25)<em>B29</em>B32)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUE TO THE IMMUNIZATION PROGRAM...</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Note: the same relative formulas for columns C - G; use $ to copy the unchanged row references</td>
</tr>
<tr>
<td>47</td>
<td>Number of prevented cases =G$6<em>B$42</em>B$40*B$44</td>
</tr>
<tr>
<td>48</td>
<td>Number of prevented deaths =B$48*B$19</td>
</tr>
<tr>
<td>49</td>
<td>Days of healthy life gained =B$34*B$48</td>
</tr>
<tr>
<td>50</td>
<td>Years of healthy life gained =B$52/365</td>
</tr>
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</table>

3. Entries and formulas Table 2 -- bottom portion (see Appendix)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
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<tbody>
<tr>
<td>ANNUAL PROGRAM COSTS</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Total =SUM(B$65:B$73)</td>
</tr>
<tr>
<td>76</td>
<td>Average =AVG(B77:F77)</td>
</tr>
<tr>
<td>77</td>
<td>Present Value of Average =NPV(G8,B77:F77)/B8</td>
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</tbody>
</table>
4. Entries and formulas for Table 3 (see Appendix)

<table>
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<th>A</th>
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</tbody>
</table>

Table 3. Cost-effectiveness of immunization program by type of vaccine, xx Region.

<table>
<thead>
<tr>
<th>Type of Vaccine</th>
<th>Unit Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DPT</td>
</tr>
<tr>
<td>Cost per Vaccine Dose</td>
<td>(-\frac{$81}{($81*$81*8)})</td>
</tr>
<tr>
<td>Cost per Fully Vaccinated Child</td>
<td>(-\frac{3}{8}\frac{$81}{($81*$81*8)})</td>
</tr>
<tr>
<td>Cost per Prevented Case</td>
<td>(-\frac{3}{8}\frac{$81}{\text{SUM}(B48:D48)})</td>
</tr>
<tr>
<td>Cost per Prevented Death</td>
<td>(-\frac{3}{8}\frac{$81}{\text{SUM}(B50:D50)})</td>
</tr>
<tr>
<td>Cost per Day of Healthy Life Gained</td>
<td>(-\frac{3}{8}\frac{$81}{\text{SUM}(B52:D52)})</td>
</tr>
<tr>
<td>Cost per Year of Healthy Life Gained</td>
<td>(-\frac{365}{3}\frac{3}{8}\frac{$81}{\text{SUM}(B52:D52)})</td>
</tr>
</tbody>
</table>

5. Entries and formulas Table 4 (see Appendix)

<table>
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<th>C</th>
<th>D</th>
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<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Cost-effectiveness of immunization program by specific disease, xx Region.

<table>
<thead>
<tr>
<th>Target Diseases</th>
<th>Diphtheria</th>
<th>Pertussis</th>
<th>Tetanus</th>
<th>Poliomyelitis</th>
<th>Tuberculosis</th>
<th>Measles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Program</td>
<td>(-\frac{3}{8}\frac{$81}{$81})</td>
<td>(-\frac{3}{8}\frac{$81}{$81})</td>
<td>(-\frac{3}{8}\frac{$81}{$81})</td>
<td>(-\frac{3}{8}\frac{$81}{$81})</td>
<td>(-\frac{3}{8}\frac{$81}{$81})</td>
<td>(-\frac{3}{8}\frac{$81}{$81})</td>
</tr>
<tr>
<td>Cost per Prevented Case</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
</tr>
<tr>
<td>Cost per Prevented Death</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
</tr>
<tr>
<td>Cost per Year of Healthy Life Gained</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
<td>(-\frac{$109}{$109})</td>
</tr>
</tbody>
</table>
D. Create graphs to promote rapid understanding of the results

1. Use the graph function of Excel

2. Example showing results from output in Appendix

   a. Cost per prevented case (vaccine-specific)

   ![Figure 3](image1)

   **Figure 3.** Cost per prevented case by type of vaccine.

   (1) For DPT, prevented cases of diphtheria, pertussis or tetanus during the following 10 years (i.e., the duration of immunity)
   (2) For OPV, prevented cases of poliomyelitis during the life of the child (estimated as 60 years in the spreadsheet)
   (3) For BCG, prevented cases of tuberculosis during the following 15 years
   (4) For measles, prevented cases of measles during the life of the child (also estimated as 60 years in the spreadsheet)

   b. Cost per prevented death (vaccine-specific)

   ![Figure 4](image2)

   **Figure 4.** Cost per prevented death, by type of vaccine
c. Cost per year of healthy life gained (vaccine-specific)

![Graph showing cost per year of healthy life gained by vaccine type.]

**Figure 5.** Cost per year of healthy life gained, by type of vaccine.

d. Cost per year of healthy life gained (disease-specific)

![Graph showing cost per year of healthy life gained for selected diseases.]

**Figure 6.** Cost per year of healthy life gained, for selected diseases.

### VI. CONCLUDING REMARKS ON COST-EFFECTIVENESS ANALYSIS

A. Advantages of spreadsheet model for planning immunization strategies

1. Provides insight based on known information
   
   a. Use existing data for cost and disease components
   
   b. Determine effect of known values on cost and disease outcomes

2. Indicates areas of further research
a. Focus on parameters of disagreement
b. Do sensitivity analysis for parameters in question
   (1) Determine effect on conclusions
   (2) If effect is pronounced, conduct additional field studies

B. Disadvantage for planning immunization strategies

1. The results of cost-effectiveness analyses do not always indicate the best decision to be made
   a. Strategies with the lowest cost for the most effect may not fully reflect the social values of the society
   b. The benefits of an alternative strategy may be much greater than the selected policy
      (1) Using effectiveness rather than benefits as the consequence of the immunization strategy may provide too narrow a focus and lead to the implementation of a less desirable strategy
### APPENDIX

**COST-EFFECTIVENESS OF CHILDHOOD IMMUNIZATION PROGRAMS**

| | A | | B | | C | | D | | E | | F | | G |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total population in service area | 2,360,000 | Neonatal mortality in service area | .024 |
| Crude birth rate in service area | .032 | Expected eligible child population in the service area per year | 73,708 |
| Duration of program planning period (in years) | 5 | Annual Discount Rate for Program Costs | .085 |

**Table 1. Days of healthy life gained in the service area population due to the immunization program, xx Region.**

<table>
<thead>
<tr>
<th>DHLI Formula Component</th>
<th>Diphtheria</th>
<th>Pertussis</th>
<th>Tetanus</th>
<th>Poliomyelitis</th>
<th>Tuberculosis</th>
<th>Measles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. age of disease onset</td>
<td>3</td>
<td>1</td>
<td>15</td>
<td>3</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Av. life exp. at disease onset</td>
<td>53.0</td>
<td>52.4</td>
<td>46.5</td>
<td>52.0</td>
<td>42.5</td>
<td>53.0</td>
</tr>
<tr>
<td>Av. case-fatality</td>
<td>.07</td>
<td>.01</td>
<td>.35</td>
<td>.05</td>
<td>.35</td>
<td>.03</td>
</tr>
<tr>
<td>Av. age at death due to disease</td>
<td>3</td>
<td>1</td>
<td>15</td>
<td>3</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Prop. disablement prior to death</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.25</td>
</tr>
<tr>
<td>Av. case-disability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.95</td>
</tr>
<tr>
<td>Prop. disablement among disabled</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.25</td>
</tr>
<tr>
<td>Days of temporary disability</td>
<td>37</td>
<td>37</td>
<td>32</td>
<td></td>
<td>400</td>
<td>26</td>
</tr>
<tr>
<td>Prop. disablement during temp. disability days</td>
<td>.80</td>
<td>.80</td>
<td>.95</td>
<td></td>
<td>.50</td>
<td>.80</td>
</tr>
</tbody>
</table>

**DAYS OF HEALTHY LIFE LOST PER CASE** | 1,382 | 221 | 5,960 | 5,457 | 5,080 | 601 |

| Exp. duration of immunity (years) | 10 | 10 | 10 | 60 | 15 | 60 |
| Expected cumulative incidence among UNVACCINATED persons during duration time of immunity | .0050 | .2000 | .0080 | .0100 | .0300 | .9000 |
| Proportion of population vaccinated | .70 | .70 | .70 | .70 | .95 | .85 |
| Estimated vaccine effectiveness | .85 | .85 | .85 | .80 | .50 | .80 |
Table 1. Days of healthy life gained in the service area population due to the immunization program, xx Region (continued).

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUE TO THE IMMUNIZATION PROGRAM...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of prevented cases</td>
<td>219</td>
<td>8,771</td>
<td>351</td>
<td>413</td>
<td>1,050</td>
<td>45,109</td>
<td></td>
</tr>
<tr>
<td>Number of prevented deaths</td>
<td>15</td>
<td>88</td>
<td>123</td>
<td>21</td>
<td>368</td>
<td>1,353</td>
<td></td>
</tr>
<tr>
<td>Days of healthy life gained</td>
<td>302,974</td>
<td>1,934,610</td>
<td>2,091,100</td>
<td>2,252,340</td>
<td>5,336,016</td>
<td>27,089,129</td>
<td></td>
</tr>
<tr>
<td>Years of healthy life gained</td>
<td>830</td>
<td>5,300</td>
<td>5,729</td>
<td>6,171</td>
<td>14,619</td>
<td>74,217</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Cost of the immunization program, xx Region.

<table>
<thead>
<tr>
<th></th>
<th>Year of Program Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget Categories</td>
<td>Year 1</td>
</tr>
<tr>
<td>ANNUAL ITEMIZED COSTS</td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>$260,400</td>
</tr>
<tr>
<td>Facilities</td>
<td>$84,000</td>
</tr>
<tr>
<td>Materials and Equipment</td>
<td>$169,400</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>$15,400</td>
</tr>
<tr>
<td>Patient Inputs</td>
<td>$3,150</td>
</tr>
<tr>
<td>ANNUAL PROGRAM COSTS</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$532,350</td>
</tr>
<tr>
<td>Average</td>
<td>$528,626</td>
</tr>
<tr>
<td>Present Value of Average</td>
<td>$450,914</td>
</tr>
</tbody>
</table>
Table 3. Cost-effectiveness of immunization program by type of vaccine, xx Region.

<table>
<thead>
<tr>
<th>Type of Vaccine</th>
<th>DPT</th>
<th>OPV</th>
<th>BCG</th>
<th>Measles</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per Vaccine Dose</td>
<td>$1.09</td>
<td>$1.09</td>
<td>$1.09</td>
<td>$1.09</td>
<td>$4.37</td>
</tr>
<tr>
<td>Cost per Fully Vaccinated Child</td>
<td>$3.28</td>
<td>$3.28</td>
<td>$1.09</td>
<td>$1.09</td>
<td>$8.74</td>
</tr>
<tr>
<td>Cost per Prevented Case</td>
<td>$18.10</td>
<td>$409.66</td>
<td>$53.66</td>
<td>$1.25</td>
<td>$482.68</td>
</tr>
<tr>
<td>Cost per Prevented Death</td>
<td>$748.67</td>
<td>$8,193.23</td>
<td>$153.32</td>
<td>$41.65</td>
<td>$9,136.87</td>
</tr>
</tbody>
</table>

Table 4. Cost-effectiveness of immunization program by specific disease, xx Region.

<table>
<thead>
<tr>
<th>Target Diseases</th>
<th>Diphtheria</th>
<th>Pertussis</th>
<th>Tetanus</th>
<th>Poliomyelitis</th>
<th>Tuberculosis</th>
<th>Measles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per Prevented Case</td>
<td>$257.04</td>
<td>$6.43</td>
<td>$160.65</td>
<td>$409.66</td>
<td>$53.66</td>
<td>$1.25</td>
</tr>
<tr>
<td>Cost per Prevented Death</td>
<td>$3,672.04</td>
<td>$642.61</td>
<td>$459.00</td>
<td>$8,193.23</td>
<td>$153.32</td>
<td>$41.65</td>
</tr>
<tr>
<td>Cost per Year of Healthy Life Gained</td>
<td>$67.90</td>
<td>$10.63</td>
<td>$9.84</td>
<td>$27.40</td>
<td>$3.86</td>
<td>$.76</td>
</tr>
</tbody>
</table>