STRATEGIES FOR DISEASE CONTROL

"To do the greatest good, health services should be directed toward controlling those diseases producing the largest amount of death and disability, and care should be made accessible to the greatest number."

- Walsh and Warren, 1980

I. PLANNING FOR DELIVERY OF HEALTH SERVICES AT COMMUNITY LEVEL

A. Estimate causes of disease in population
   1. Existing health information system
   2. Health surveys

B. Estimate death and disability attributed to each disease
   1. Existing health information system
   2. Health surveys
   3. Review of medical literature

C. Estimate the feasibility of control procedures for each disease
   1. Review of medical and public health literature

D. Rank diseases by level of importance and feasibility for control

E. Rank intervention strategies as to cost and effectiveness
   1. Review of medical and public health literature
   2. Program evaluation research

F. Select the most efficient control strategy for each disease

II. DETERMINING STRATEGIES FOR DISEASE CONTROL

A. Total Primary Health Care
   2. Goal is to improve the physical environment and provide various components of health care, education and promotion for all persons in a population
   3. Components
      a. Provision of adequate supply of safe water
      b. Provision of basic sanitation
c. Prevention and control of locally endemic diseases

4. Part of the development process of a community
a. Need information to create awareness within the community
   (1) Epidemiologic data
   (2) Environmental data
   (3) Health services data
b. Attempt to empower the community to deal with its own problems
   (1) Wide dissemination of information
   (2) Discussion of information in community meetings
   (3) Development of a plan of action
   (4) Implementation
   (5) Evaluation

B. Basic primary health care

1. Goal is to provide health workers and establish clinics for treating all illnesses and preventing selected diseases within a population

2. Usual personnel
   a. Community health workers
   b. Auxiliary nurse midwives
   c. Midwives
   d. Nurses/Non-physician practitioners

3. Conclusions of Walsh and Warren
   "...under some circumstance...have been successful, but the cost as well as the degree of improvements in community health have varied markedly enough that refinements in the approach still need to be made."

C. Broadly-based Disease Control Programs

1. Vector Control
   a. Programs directed at managing insect, mollusc and other carriers of human disease
   b. Requires perpetual maintenance
   c. Vectors may develop resistance over time

2. Water and Sanitation Programs
   a. Usually considered effective but expensive
   b. Success necessitates behavioral changes with respect to use of clean water and the disposal of excrements

3. Nutrition supplementation
   a. Malnutrition appears to increase susceptibility to infectious diseases
   b. Infectious diseases appear to increase the level of malnutrition
c. Success is dependent on offering acceptable foods of high biological value to the population in need

D. Selective Primary Health Care Programs

1. The most selective of the various medical intervention strategies
2. Assumes that only a few diseases are targeted for prevention or intervention in a define population
3. Example proposed by Walsh and Warren
   a. Based on a cost-effectiveness analysis
      (1) Change in mortality is the indicator of effectiveness
      (2) No attempt was made to measure potential benefits other than reduction in mortality
   b. Population
      (1) Children, aged 0-3 years
      (2) Women in childbearing years
   c. Specific Program
      (1) Children, aged 0-3 years
         (a) Measles and DPT vaccination for children over 6 months
         (b) In Malarious areas, chloroquine for children under 3 years to ingest during febrile episodes
         (c) Oral rehydration packets and instructions
      (2) Women in childbearing years
         (a) Tetanus toxoid to pregnant women
         (b) Encouragement of long-term breast feeding
   d. Mode of delivery
      (1) Mobile units visiting every 4-6 months
         (a) Assumes the areas are geographically accessible
         (b) The authors believe this to be the most economical
      (2) Fixed units offering continuous services
4. Past Example, UNICEF (United Nations Children's Fund)
   a. Minimum package of services for child survival (GOBI)
      (1) Growth monitoring
      (2) Oral rehydration
      (3) Breastfeeding
      (4) Immunization
   b. Expanded activities (GOBI - FFF)
      (1) Female education
      (2) Family spacing
      (3) Food supplements

III. RESEARCH

A. Need to support research on important diseases for which effective vaccines or chemotherapy can be developed

1. Obstacles to vaccine introduction
   b. Five issues and concerns
      (1) Although in the late 1980s delivery of basic childhood vaccines—bacille
Calmette-Guérin (BCG) against tuberculosis, polio vaccine, diphtheria-tetanus-pertussis vaccine and measles vaccine — by the Expanded Programme on Immunization (EPI) had risen to achieve worldwide coverage of about 80% of infants, these gains faltered thereafter, especially in sub-Saharan Africa, where in 2000 less than 50% of infants had received their third dose of diphtheria-tetanus-pertussis vaccine. This trend underscored the difficulties that would be encountered in adding new vaccines to programs in settings such as developing countries.

(2) An increasing divergence between vaccine products used in the industrialized versus developing worlds arose in the 1990s. This divergence included newer generation vaccines, such as vaccines against hepatitis B and Haemophilus influenzae type b (Hib). Such vaccines had become commonplace in the industrialized world, yet were not being used widely in the developing world largely because of their expense, creating pessimism about the likelihood that newly developed vaccines would be introduced in the developing world. Moreover, several vaccines and vaccine formulations that had formerly been used jointly in industrialized and developing country populations ceased to be recommended in industrialized countries. For example, whole-cell pertussis vaccine had largely been replaced by acellular pertussis vaccine in the industrialized world, but continued to be used in the developing world, because of its low cost. This trend threatened to reduce the supply of many vaccines recommended for the developing world, as major vaccine producers tailored their portfolios to vaccines for the industrialized world.

(3) There was little incentive for the vaccine industry in the industrialized world, the major source of innovative vaccines, to develop new vaccines against diseases that were largely limited to the developing world, as industrialized world markets were more lucrative. Examples of these diseases included malaria, tuberculosis, shigellosis, enterotoxigenic Escherichia coli diarrhea, cholera, typhoid fever, invasive group A meningococcal disease, dengue fever, hepatitis E, leishmaniasis and schistosomiasis.

(4) Several factors, including the increasing stringency of regulations imposed by national vaccine licensing authorities, had increased the costs of clinical development pathways for licensure of vaccine candidates to hundreds of millions of dollars. This meant that new generation vaccines would have to cost dollars per dose in order for industry to recover an adequate return on its investment — in contrast to the pennies per dose cost of the traditional EPI vaccines — and it was not clear how these costs would be borne for developing country populations.

(5) It had become increasingly common to find that vaccines performed less well in developing country populations than in populations residing in the industrialized world. These disparities meant that trials of vaccines in developing countries were needed before their introduction in these settings. But trials in developing countries were not a priority for large producers in the industrialized world, and, if they were undertaken, they were typically deferred for years after vaccine licensure in industrialized countries, leading to delays in vaccine introduction.

B. Need to develop indices for assessing the cost-effectiveness of intervention or prevention
programs which have multiple effects

1. Should not be limited to just mortality
2. Should not be limited to just one disease

C. Need to evaluate the quality of care

1. How accurate is the diagnosis made by the health workers
2. Given that the diagnosis is correct, how likely are the health workers to prescribe the proper treatment or preventive activity
3. Given that the diagnosis is correct and the proper treatment has been allocated, how frequently do the health workers adequately explain to the patients what needs to be done
4. How likely are patients to comply with the treatment or preventive activity prescribed to them

D. Need to support research on cost-effective means for the delivery of services to impact the level of disease in the community

1. How do social or cultural factors affect the use of health services in a specified community
   a. Examples
      (1) Non-use of oral rehydration therapy
      (2) Attrition among those scheduled for second and third doses of DPT vaccine
      (3) Non-use of dapsone among leprosy patients

2. What types of financial mechanisms need to be established to fund various service activities
   a. Government funding
   b. Private sector

3. What means are available for producing quality drugs and other supplies in-country, thereby reducing cost while maintaining efficacy
4. What logistical systems are needed to insure an orderly and timely delivery of drugs, equipment and other supplies to the providers of care

IV. ASSUMPTIONS OF MANY PROPOSALS FOR SELECTIVE PRIMARY HEALTH CARE

A. Required knowledge of intervention/prevention programs already exists

1. Only need to...
   a. garner political support for appropriate programs or activities
   b. seek necessary funding
   c. improve the management capacity

B. Modern technology has the potential to greatly reduce the burden due to morbidity and mortality
1. Mass communication for modification of health-related behavior
   a. Radio and television
   b. Promote use of family planning methods
   c. Promote immunization, oral rehydration and growth monitoring activities
2. Rapid access to quality medical and surgical care
   a. Mobile clinics
   b. "Flying Doctors"
3. Telecommunications
   a. Facsimile transmission (FAX)
   b. Electronic mail (Email) correspondence
   c. Internet access to World Wide Web
4. Maintaining the cold chain
   a. Kerosene refrigerators
   b. Solar-powered refrigerators
5. Rapid community-based surveys
   a. Portable battery-powered microcomputers
   b. User-friendly software

V. SELECTIVE PRIMARY HEALTH CARE PROGRAM (EXAMPLE)

A. International Center for Diarrhea Disease Research (ICDDRB)
   1. Matlab District, Bangladesh
   2. Originally set up to do cholera vaccine trials (early 1960's)
   3. Collected diarrhea data to ensure reporting of all cholera cases
   4. Historical pattern of crude birth and death rates (see Table 1 in Chen article)

B. Comparison of two groups (see Chen, 1986)
   1. Intervention group
      a. active delivery of family planning services
         (1) started in January, 1978
      b. active delivery of MCH services
         (1) tetanus toxoid for pregnant women started in July, 1978
      c. active promotion of oral rehydration therapy use
         (1) started in January, 1979
   2. Control group
      a. offered regular government health services
      b. given access to diarrhea treatment unit

C. Causes of mortality (see Table II, p. 1261, Chen, 1986)
   1. “From the data in Table II oral rehydration (for diarrhea), tetanus, measles and pertussis vaccination could theoretically reduce mortality by around 50%.”

D. Results
   1. Discrepancy between theory and fact
      a. Selective Primary Health Care
         (1) Diarrhea - oral rehydration therapy
(2) Tetanus, measles, and pertussis - vaccination
(3) Other infectious diseases - antibiotics

b. Theoretical reduction in mortality
(1) Based on mortality data and Attributable Fraction analysis (example follows for malnutrition)
(2) Stated that program could theoretically reduce mortality by 50 percent
   (a) Including a 26 percent reduction due to the elimination of neonatal tetanus

c. Actual reduction in mortality (see Table III in Chen article)
(1) Very little impact on infant, neonatal or post-neonatal mortality

d. Moderate reduction in birth rate

2. Possible Reasons for Discrepancy between Theory and Fact
   a. REASON 1: Postponement rather than aversion of death

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<th>Treatment</th>
<th>Time of death if no treatment</th>
<th>Time of actual death</th>
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(1) Explanation of problem using spreadsheet modeling techniques
   (a) Postponement of death during the neonatal period
      i) birth through 27 days of life
   (b) Artificial data set with 100 births
      i) Probability of death during neonatal period = 0.145
         a) "True" neonatal mortality rate is set at 145 per 1,000 live births
      ii) Estimate "true" value based on a sample of 100 births
         a) Variability of estimate
      iii) Two steps for baseline setting
         a) Randomly determine if each of the 100 births will die
         b) Determine the date they will die
            • Use a logarithmic function so that proportionally more deaths occur in the neonatal period (the highest risk period)
      iv) Three steps for each day death is postponed
         a) Randomly determine if each of the 100 births will die
         b) Determine the date they will die
            c) Add one (or more) days to the date they will die
               • If death after postponement does not occur during the neonatal period (i.e., >27 days), it is not counted when deriving the neonatal death rate
   (c) 20 simulation trials were run per postponement day
      i) Number of days death is postponed = 0, 1, 2, 3, 4, 5, 6, 7
ii) In real life, there is only one trial

iii) Use results to compare two measures of improvements in health status
   a) Neonatal Mortality Rate (NMR) per 1,000 births
      
      \[
      \text{Deaths, Aged 0-27 days} \\
      \text{1,000 live births}
      \]

   b) Days of Life Lost (DLL) per 1,000 births

   \[
   \sum \text{Days of Life Lost before age 28 days} \\
   \text{1,000 live births}
   \]

iv) Table 5-1 - Example of 20 simulation trials at baseline (postponement = 0)
Table 5-1. Neonatal deaths in 20 simulation trials with post-ponement = 0.

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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8-14</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>15-27</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>100</td>
<td>22</td>
<td>11</td>
<td>4</td>
<td>7</td>
<td>220</td>
<td>1-7</td>
<td>396</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8-14</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15-27</td>
<td></td>
</tr>
</tbody>
</table>

Mean 100 15.1 9.0 2.8 3.3 150.5 90.0 27.5 33.0 295.3 2,953.0

a) Distribution of neonatal mortality rates for the 20 simulation trials shown in Table 5-1 (see Figure 5-1)
Table 5-2 - Example of the mean of 20 simulation trials per policy (i.e., postponement = 0-7 days)

a) The average value is derived for the 20 simulation trials of each tested policy (i.e., the policy that sets the number of postponement days)

b) Percent decline in Neonatal Mortality Rate (NMR)

\[
\frac{NMR_0 - NMR_{1..7}}{NMR_0} \times 100
\]

c) Percent decline in Days of Life Lost (DLL) Index

\[
\frac{DLL_0 - DLL_{1..7}}{DLL_0} \times 100
\]
Table 5-2. Mean of 20 simulation trials for death postponement policies.

<table>
<thead>
<tr>
<th>Days Death is Delayed</th>
<th>No. of births</th>
<th>No. of deaths</th>
<th>Age at Death (days)</th>
<th>Neornatal Death Rate</th>
<th>Age at Death (days)</th>
<th>Days of Life Lost</th>
<th>Days of Life Lost per 1,000 Births</th>
<th>Percent decline in...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1-7</td>
<td>8-14</td>
<td>15-27</td>
<td>1-7</td>
<td>8-14</td>
<td>15-27</td>
<td>NMR</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
<td>15.1</td>
<td>9.0</td>
<td>2.8</td>
<td>3.3</td>
<td>90.0</td>
<td>27.5</td>
<td>33.0</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>14.5</td>
<td>8.3</td>
<td>3.1</td>
<td>3.0</td>
<td>83.0</td>
<td>31.5</td>
<td>30.5</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>15.0</td>
<td>7.0</td>
<td>4.2</td>
<td>3.8</td>
<td>70.0</td>
<td>42.0</td>
<td>38.0</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>14.1</td>
<td>6.9</td>
<td>4.0</td>
<td>3.1</td>
<td>69.0</td>
<td>40.5</td>
<td>31.5</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>14.0</td>
<td>5.4</td>
<td>5.1</td>
<td>3.5</td>
<td>54.0</td>
<td>51.0</td>
<td>35.0</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>14.9</td>
<td>4.2</td>
<td>5.7</td>
<td>4.0</td>
<td>42.0</td>
<td>56.5</td>
<td>40.5</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>13.4</td>
<td>1.1</td>
<td>7.8</td>
<td>4.5</td>
<td>11.0</td>
<td>78.5</td>
<td>45.0</td>
</tr>
<tr>
<td>7</td>
<td>100</td>
<td>12.1</td>
<td>0.0</td>
<td>7.5</td>
<td>4.5</td>
<td>0.0</td>
<td>75.5</td>
<td>45.0</td>
</tr>
</tbody>
</table>

d) Example of calculations for death delay of 1 day

- Percent decline in Neonatal Mortality Rate (NMR)
  \[
  \frac{150.5 - 145.0}{150.5} \times 100 = 3.7\% \text{ decline}
  \]

- Percent decline in Days of Life Lost (DLL) Index
  \[
  \frac{295.3 - 280.3}{295.3} \times 100 = 5.1\% \text{ decline}
  \]

e) Change in rates during the neonatal period due to postponement of death (see Figure 5-2; based on data in Table 5-2)
Figure 5-2. Effect of postponement of neonatal deaths on early neonatal, middle neonatal and late neonatal mortality rates.

Figure 5-3. Effect of postponement on percent reduction in neonatal mortality rate (NMR) and days of life lost (DLL).

f) Percentage improvement in neonatal mortality rate and days of life lost during the neonatal period due postponement of death (see Figure 5-3; based on data in Table 5-2)
(2) Solution - use methods incorporating life expectancy rather than mortality rates to measure this
   (a) Potential years of life lost (PYLL)
       i) based on mortality
   (b) Days of healthy life lost (DHLL)
       i) based on mortality and disability

b. REASON 2: Disease control program did not focus on reducing the level of malnutrition

(1) Theoretical impact of malnutrition (Table V, p. 1262, Chen, 1986)

   (a) Table of findings

<table>
<thead>
<tr>
<th></th>
<th>Dead</th>
<th>Alive</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malnourished (Exp)</td>
<td>73</td>
<td>668</td>
<td>741</td>
</tr>
<tr>
<td>Better nourished (Unexp)</td>
<td>39</td>
<td>1,262</td>
<td>1,280</td>
</tr>
<tr>
<td>totals</td>
<td>112</td>
<td>1,930</td>
<td>2,021</td>
</tr>
</tbody>
</table>

   Where: $M_e = \text{mortality rate among children "exposed" to malnutrition}$
   $M_u = \text{mortality rate among children "unexposed" to malnutrition (i.e., in "better nourished" group)}$
   $M_t = \text{mortality rate among all children (i.e., both malnourished and better nourished) in the population}$

   (b) Risk ratio
   i) Relative risk of mortality associated with being in the malnourished versus better nourished group

   $$RR = \frac{M_e}{M_u} = \frac{98.5/1,000}{30.5/1,000} = 3.23$$

   ii) Malnourished children were 3.23 times more likely to die than better nourished children

   (c)Attributable fraction in the population ($AF_p$)
   i) Proportion of deaths in the total population which is theoretically due to being malnourished.
   ii) For concept see Figure 5-4 (data from above four-fold table)
iii) Calculations (see Figure 5-4 for concept and Figure 5-5 for graph of results)

a) Method One (featured in most epidemiology texts)

\[
\frac{M_t - M_u}{M_t} = \frac{55.4 - 30.5}{55.4} = 0.45 = 45\%
\]

b) Method Two (featured in Chen article; for data see Table V, p1262)

- First derive \(Exp_e\)

\[Expected_{\text{malnourished}} = \text{Exp}_e = \text{Mortality rate}_{\text{better nourished}} \times Subjects_{\text{malnourished}} = M_u \times N_e = 23\]

where \(N_e = \) the number of children in the group "exposed" to malnutrition

\(\text{Exp}_e = \) the number of expected deaths among the "exposed" children (i.e., the malnourished group) if they had experienced the same mortality rate as the "unexposed" children (i.e., better nourished group)

- Then calculate \(AF_p\)

\[AF_p = \frac{Obs_e - \text{Exp}_e}{Obs_t} = \frac{73 - 23}{112} = \frac{50}{112} = 0.45 = 45\%
\]

where \(Obs_e = \) the observed number of deaths in the "exposed" (i.e., malnourished) group
$\text{Obs}_e - \text{Exp}_e$ = the number of deaths in the population theoretically attributed to the effects of malnutrition (i.e., to the exposure factor). (Obs$_e$ - Exp$_e$) is cited in Table V, p 1262 as "Actual - Expected" (73 and 23 in columns "Malnourished") and as 50 in the column entitled "nutrition-related Yes."

$\text{Obs}_t$ = the observed number of deaths in the total population (i.e., both the better nourished and malnourished children)

NOTE FOR EPIDEMIOLOGY MAJORS:

<table>
<thead>
<tr>
<th>Disease</th>
<th>No Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp.</td>
<td>A</td>
</tr>
<tr>
<td>Unexp.</td>
<td>C</td>
</tr>
</tbody>
</table>

In typical four-fold table shown at right...

$\text{AF}_p = \frac{\text{Obs}_e - \text{Exp}_e}{\text{Obs}_t} = \frac{A - A_0}{A + C} = \frac{A_1}{A + C}$

(d) Attributable fraction among exposed ($\text{AF}_e$)

i) Proportion of deaths among those exposed to the harmful affects of malnourished which is theoretically due to being malnourished.

ii) Calculations (see Figure 5-5 for graph of results)

a) Method One (featured in most epidemiology texts)

$$\frac{M_e - M_u}{M_e} = \frac{98.5 - 30.5}{98.5} = 0.69 = 69\%$$

b) Method Two (featured in Chen article)

- First derive $\text{Exp}_e$

$$M_u \times N_e = \text{Exp}_e$$

- Then calculate $\text{AF}_e$

$$\text{AF}_e = \frac{\text{Obs}_e - \text{Exp}_e}{\text{Obs}_e} = \frac{73 - 23}{73} = \frac{50}{73} = 0.69 = 69\%$$
NOTE FOR EPIDEMIOLOGY MAJORS:

In typical four-fold table shown at right...

<table>
<thead>
<tr>
<th></th>
<th>Disease</th>
<th>No Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp.</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Unexp.</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

where cases not attributed to exposure are derived as $A_0$ by multiplying $C/D$ times $A+B$...

\[
\frac{Obs_e - Exp_e}{Obs_e} = \frac{A - A_0}{A} = \frac{A_1}{A} = AF_e
\]

iii) Infection-nutrition interaction

(e) Malnourished children are more susceptible to a wide variety of illnesses

i) Child who avoids one disease dies from another

Figure 5-5. Attributable fraction among malnourished children ($AF_e$) and among all children ($AF_p$)

-16-
c. **REASON 3: Biological efficacy versus community effectiveness**

(1) **Efficacy**
   (a) Under *optimum* conditions, does the vaccine or drug prevent or cure the disease of interest
   (b) Usually assessed in a clinical setting or tightly controlled clinical trials

(2) **Effectiveness**
   (a) Under *actual* conditions, does an immunization or medical care program prevent or cure the disease of interest

(3) **Example**
   (a) Tetanus toxoid (TT) during pregnancy to prevent neonatal tetanus in the offspring
      i) **Expected** reduction in infant mortality
         a) 26% of infant deaths are due to tetanus
         b) Biological efficacy of TT is nearly 100%
         c) Expect 26% reduction in infant mortality
      ii) **Observed** reduction in infant mortality
         a) Less than 3% reduction in infant mortality
         b) Vaccine was accepted by only 22% of mothers
            - This appears to be the **major factor** for the modest reduction in infant mortality

c) **Example** Using Data from Table II, p. 1261, Chen, 1986 is presented below and on the following page, and is shown in Figure 5-6

![Figure 5-6](image-url)
Prop. vaccinated = 0.22 (22% vaccination coverage)

Infant Mortality = 0.1426 (142.6 deaths/1,000 live births; see Table II in Chen)

Tetanus Mortality = 0.0374 (37.4 deaths due to tetanus/1,000 live births)

<table>
<thead>
<tr>
<th>Expected Outcome if TT Vaccine has No Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant Death</td>
</tr>
<tr>
<td>YES</td>
</tr>
<tr>
<td>Tetanus Other NO</td>
</tr>
<tr>
<td>Vaccinated with saline (no effect)</td>
</tr>
<tr>
<td>YES (v)</td>
</tr>
<tr>
<td>82   231  1,896  2,200  ( M_v = (82+231)/2,200 = 0.1426 )</td>
</tr>
<tr>
<td>NO (uv)</td>
</tr>
<tr>
<td>292  821  6,688  7,800  ( M_{uv} = (292+821)/7,800 = 0.1426 )</td>
</tr>
<tr>
<td>374  1,052  8,574  10,000  ( M_t = (374+1,052)/10,000 = 0.1426 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expected Outcome if TT Vaccine is 100% Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant Death</td>
</tr>
<tr>
<td>YES</td>
</tr>
<tr>
<td>Tetanus Other NO</td>
</tr>
<tr>
<td>Vaccinated with TT</td>
</tr>
<tr>
<td>YES (v)</td>
</tr>
<tr>
<td>0    231  1,969  2,200  ( M_v = (0+231)/2,200 = 0.1052 )</td>
</tr>
<tr>
<td>NO (uv)</td>
</tr>
<tr>
<td>292  821  6,688  7,800  ( M_{uv} = (292+821)/7,800 = 0.1426 )</td>
</tr>
<tr>
<td>292  1,052  8,656  10,000  ( M_t = (292+1,052)/10,000 = 0.1344 )</td>
</tr>
</tbody>
</table>

- Prevented fraction of infant mortality in population (\( PF_p \)) — expected reduction is 5.8%

\[
PF_p = \frac{M_{uv} - M_t}{M_{uv}} = \frac{0.1426 - 0.1344}{0.1426} = 0.058 = 5.8\%
\]

VI. COST-EFFECTIVENESS OF SELECTIVE PRIMARY HEALTH CARE ACTIVITIES

A. Effectiveness is assessed with a single outcome measure when the intervention has multiple effects

1. Example
   a. Water and sanitation
      (1) Wide variety of diseases
      (2) Aesthetics, convenience
   b. Fertility reduction
      (1) Should lead to reduction in total mortality (i.e., the crude mortality rate)
         (a) Reduction in infant mortality
i) Fewer infants are born
   ii) Fewer infants who would eventually die

(b) Reduction in maternal mortality
   i) Delay childbearing until reaching a safer age
   ii) Increasing spacing of children
   iii) Less nutrient depletion during pregnancy

(c) Reduction in child mortality
   i) Longer duration of breastfeeding
   ii) Larger proportion of household resources of food, commodities, and child-care time

Note: Figure 1 (Chen article, p. 1261) does not indicate, however, that family planning led to a reduction in the crude mortality rate

c. Education of females
   (1) Improved child survival
      (a) Marry and have children at a later date
      (b) More resources for the child within the family
         i) Educated women tend to be more assertive in family decision-making
   (2) Improved health of the family
      (a) More resources for the family
         i) Educated individuals tend to have higher incomes
      (b) More effective use of health services
      (c) Better hygiene practices

d. Growth monitoring
   (1) Improved child survival
      (a) Correct severe level of malnutrition
   (2) Improve child physical and mental performance
      (a) Detecting and correcting early faltering in growth pattern
   (3) Improve future productivity at an adult age
   (4) Use as a social device to promote frequent interactions between the mother and health worker
      (a) Early detection of other problems
      (b) Promotes health education

B. When considering costs and effectiveness of programs or policies, should rely on strengths of both natural and social sciences

1. Costs
   a. Epidemiologists (often of only limited assistance)
   b. Other public health investigators with a background in fields such as economics, finance, or accounting

2. Effectiveness
   a. Disease outcomes in a population setting
      (1) Epidemiologists
   b. Etiologic factors of a biological nature
      (1) Epidemiologists and other biomedical scientists
   c. Etiologic factors of an environmental nature
      (1) Epidemiologists (often limited in scope)
      (2) Other public health investigators with a background in fields such as environmental sanitation or hygiene, sanitary engineering, or toxicology
d. Etiologic factors of a behavioral or social nature
   (1) Epidemiologists (often limited in scope)
   (2) Other public health investigators with a background in fields such as
       behavioral sciences, health education, sociology, social psychology, or
       anthropology

e. Etiologic factors of a health care delivery system nature
   (1) Epidemiologists (often limited in scope)
   (2) Other public health investigators with a background in fields such as health
       services administration or management

f. Etiologic factors of a political nature
   (1) Epidemiologists (often limited in scope)
      (a) Unless the person has worked in the country for some while and is
          familiar with the history, values and structure of the society
   (2) Other public health investigators with a background in fields such as
       history, political science, or administration
   (3) Local public health investigators who are familiar with the problems of
       their society and have an analytic mind