ESTABLISHING PROGRAM PRIORITIES BASED ON BURDEN OF ILLNESS

"Researchers have a responsibility to generate evidence that can be used by policymakers."


I. INTRODUCTION

A. Intention is to focus the delivery of health services towards the control of diseases producing the largest amount of death and disability

B. Measurement iterative loop (8 Steps)

1. **STEP 1**: Determine burden of illness
   a. Morbidity and mortality patterns in the community

2. **STEP 2**: Identify probable causative agents or factors
   a. Risk factors that contribute to or account for the burden of disease
3. **STEP 3:** Identify possible control strategies
   
a. Programs or activities that might impact the causative agents or factors at the community level

4. **STEP 4:** Assess potential benefit or effectiveness at the community level of the possible control strategies
   
a. To what degree would the potential control program impact morbidity or mortality
   
b. Must consider both the potential benefit and the potential harm to the community

5. **STEP 5:** Determine the probable cost of the possible control strategies
   
a. Assess financial investment

6. **STEP 6:** Make recommendations for programmatic action
   
a. Summarize prior findings on cost-benefit or cost-effectiveness and suggest control measures for reducing the burden of illness

**PROGRAM IMPLEMENTATION**

7. **STEP 7:** Monitor activities of the control program
   
a. Select process indicators for monitoring of program

8. **STEP 8:** Reassess impact on burden of illness
   
a. Determine if program has had an impact on the morbidity and mortality patterns of the community

II. **IDENTIFY THE BURDEN OF ILLNESS (STEP 1)**

A. Definitions of illness

1. Morbidity
   
a. Incident case, prevalent case, level of functional disability, level of mental impairment
   
b. Example - definition of diarrhea among children, aged 0-4 years

   (1) Quantitative
<table>
<thead>
<tr>
<th>Frequency</th>
<th>Number</th>
<th>Time Interval</th>
<th>Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>24 hours</td>
<td>loose or watery</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>24 hours</td>
<td>not specified</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>24 hours</td>
<td>liquid or loose</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>24 hours</td>
<td>loose or with blood or mucus</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>12 hours</td>
<td>liquid</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>24 hours</td>
<td>loose or watery</td>
</tr>
</tbody>
</table>

(2) Non-quantitative

(a) As identified by mother

(b) Twice the normal number of stools, a change in consistency of stool to runny or watery, or a history of these changes from the parents

2. Mortality

3. Combination (index of disability and mortality)

B. Problems in measuring illness

1. Standardize
   a. Define what is to be measured
   b. Have an objective technique for its measurement
   c. Define the conditions under which the technique is to be used
   d. Use trained personnel

2. Criteria for population-based measurements
   a. Simple to do (especially for large population surveys)
   b. Acceptable
   c. Reasonable cost
   d. Repeatable
   e. Accurate
3. Instrument for obtaining measurements
   a. Questionnaire asking for self-reported responses
   b. Interviews asking for responses
   c. Observers of events
   d. Examiners of subjects
   e. Actual measuring instrument or tools

C. Ways to assess the occurrence of illness and death

1. Subjective opinions of experts
   a. May be valid but difficult to confirm with confidence
   b. Delphi technique
      1. Assemble a group of experts
      2. Ask each to estimate the occurrence of disease in the geographic region of interest
      3. Calculate the average estimate value for the group and share this information with them
      4. Ask each to again estimate the occurrence of disease in the geographic area
         a) If they are not completely certain, their opinion will be most likely be modified by the average opinion of the group
      5. Recalculate the average estimate value for the group

2. Synthetic estimation
   a. Based on rates derived from the literature or reference surveys and population data from the Census
      \[ \text{RATE} \times \text{OBSERVED number of persons in area} = \text{EXPECTED events in area} \]
   b. Example - estimates for vaccination program
      1. Expected births in village during the year

Establishing Program Priorities
Birth rate = 25 births per 1,000 population per year

Population in the village of interest = 3,800

<table>
<thead>
<tr>
<th>RATE</th>
<th>OBSERVED</th>
<th>EXPECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>25/1000</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3,800</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>95 births</td>
</tr>
</tbody>
</table>

(2) Should plan during the year to vaccinate 95 children in the village of interest

(a) First dose of BCG, DPT, and OPV

c. Probably more accurate, on the average, than expert opinions

3. Various sources of existing data

a. Mortality

(1) More accurate in urban than rural areas

(a) Need for burial certificate

(2) Less accurate for children in first few weeks of life

b. Hospital data

(1) Not always available

(2) Diagnostic accuracy may be questionable if laboratory results are necessary for confirmation

c. Prior community health surveys

(1) Protocol and sampling procedures may no longer be available in written form

(2) Analysis may not have been appropriate for identifying the disease of interest

4. Newly commissioned community health survey

a. Usually provides best estimate of the occurrence of the disease of interest

(1) Assuming the survey is done in an unbiased manner

b. Most costly
5. Summary of cost and potential for bias

<table>
<thead>
<tr>
<th>METHOD</th>
<th>POTENTIAL FOR BIAS</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjective Opinion</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Synthetic Estimation</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Existing Data</td>
<td>Moderate</td>
<td>Medium</td>
</tr>
<tr>
<td>New Survey</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

D. Indices of ill health using existing and newly created data

1. Years of Potential Life Lost (YPLL)

2. Disability-adjusted Life Days (DALD)
   a. For a given disease, the sum of days lost by each patient due to….

      (1) Premature death
      (2) Disability before death
      (3) Chronic disability
      (4) Acute illness

3. Disability-adjusted Life Years (DALY)

   \[ \text{DALY} = \frac{\text{DALD}}{365 \text{ days}} \]

   a. In a given community or region, the healthy years lost due to a specific disease by the population in a given area per year are…

   DALY lost per case x annual incidence x population

III. DETERMINE PROBABLE CAUSAL MECHANISMS (STEP 2)

A. Review of the literature

   1. Journal articles and books

      a. Look for studies in country of interest or other countries in the same region of the world

   2. Determine if etiologic agents or factors have been identified and if the findings are relevant to the people in the community of interest

B. Review of existing local research studies

C. If no information is available, conduct a research study
1. Randomized clinical trial
   a. Most objective
   b. Very costly
2. Cohort study
   a. Next most objective
   b. Very costly
3. Cross-sectional study
   a. Effective for assessing prevalence but subject to extensive bias when determining etiologic relationships
   b. Intermediate in cost between clinical trials/cohort studies (usually most expensive) and case-control studies (usually least expensive)
4. Case-control study
   a. Subject to extensive bias
   b. Relatively inexpensive

D. Develop model of causation web and natural history of disease
1. Use to formulate potential prevention or intervention programs
2. Example - neonatal mortality

IV. IDENTIFY POSSIBLE CONTROL STRATEGIES (STEP 3)

A. Review of the literature

Establishing Program Priorities
1. International journal articles, reports and books
   a. See if similar problems have been solved in other countries

2. Local reports or research studies

B. Determine the feasibility of control

1. Avoidable burden
   a. Disease for which there exist feasible, effective preventive or curative measures or procedures

2. Unavoidable burden
   a. Disease for which there are no feasible, effective preventive or curative measures or procedures
   b. Need more research

C. Determine theoretical effect of various intervention/prevention efforts

1. Risk difference (RD)
   a. Formula

   \[ RD = I_e - I_u \]

   Where \( I_e \) = incidence among those exposed to the factor

   \( I_u \) = incidence among those not exposed to the factor

   b. Measures anticipated reduction in disease incidence among persons exposed to a risk factor if exposure can be prevented
c. Useful for comparing the theoretical effects of different prevention or intervention efforts aimed at persons exposed to a given risk factor

2. Attributable fraction among the exposed (AF<sub>e</sub>)

   a. Formula

   \[ AF_e = \frac{I_e - I_u}{I_e} \]

   note: the numerator is RD

   b. Measures the proportionate reduction in disease incidence among persons exposed to a risk factor if exposure can be prevented

   c. Useful for comparing the effects of different prevention or intervention efforts aimed at persons exposed to a given risk factor

3. Population excess risk (PER)

   a. Formula

   \[ PER = I_p - I_u \]

   Where \( I_p \) = incidence in the total population of exposed and unexposed persons

   (1) \( I_p \) is a weighted average of \( I_e \) and \( I_u \)

   (a) The mixture of \( I_e \) and \( I_u \) weighted by the proportion of the population that is exposed or unexposed

   \[ I_p = (P_e \times I_e) + (P_u \times I_u) \]
Where \( P_e \) = proportion of the population that is exposed to the factor of interest
\( P_u \) = proportion of the population not exposed

b. Measures anticipated reduction in disease incidence among all persons in a population if exposure to the risk factor of interest can be removed or prevented

c. Useful for comparing the anticipated impact in a population of different prevention or intervention efforts aimed at a specified disease

4. Attributable fraction in the total population \((AF_p)\)

a. Termed "etiological fraction" by Bennett et al (p 213)

b. Formula

\[ AF_p = \frac{I_p - I_u}{I_p} \]

note: the numerator is PER
c. Measures the proportionate reduction in disease incidence among all persons in a population if exposure to the risk factor of interest can be removed or prevented

d. Useful for comparing the effects of different prevention or intervention efforts aimed at a specific disease

V. DETERMINE POTENTIAL EFFECTIVENESS OF CONTROL STRATEGIES (STEP 4)

A. Derive efficacy (E) of prevention or intervention program, procedure or activity

1. Assuming optimal conditions, would the program work to reduce the burden of illness

   a. Complete diagnostic accuracy

   b. Appropriate care provided by health worker

   c. Complete compliance by patient with recommended care

2. Efficacy estimates the maximum benefit to be expected under optimal conditions

3. Usually derived from research studies

   a. Evaluate studies using rules of scientific evidence

B. Estimate the diagnostic accuracy expected in the community

1. Determine if the health workers are correctly diagnosing the disease when it is present and diagnosing patients as free of the disease when it is not present

2. Usually derived from local research studies

   TRUE DIAGNOSIS

   (physician diagnosis with laboratory confirmation)

<table>
<thead>
<tr>
<th>Sick (+)</th>
<th>Well (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>True (+)</td>
<td>False (+)</td>
</tr>
<tr>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>False (-)</td>
<td>True (-)</td>
</tr>
</tbody>
</table>

   Disease diagnosis made by health worker

   True disease

   True sick

   True well

   Apparent disease

Establishing Program Priorities 11
a. The prevalence of true disease \( (Pd) \) in the total population is...

\[
Pd = \frac{A + C}{A + B + C + D}
\]

(1) \( Pd \) can also be derived using the following formula:

\[
Pd = \frac{Pt + Sp - 1}{Se + Sp - 1}
\]

where \( Pt, Se, \) and \( Sp \) are as defined subsequently in this section of the outline

b. The prevalence of apparent disease \( (Pt; \) or test positive) in the total population is...

\[
Pt = \frac{A + B}{A + B + C + D}
\]

(1) \( Pt \) can also be derived using the following formula

\[
Pt = Pd (Se) + (1 - Pd) (1 - Sp)
\]

where \( Pd, Se, \) and \( Sp \) are as defined above and subsequently in this section of the outline

3. Sensitivity of the diagnosis \( (Se) \)

a. Proportion of persons with the disease who are correctly diagnosed as having the disease

\[
Se = \frac{True (\text{+})}{True \text{ sick}} = \frac{A}{A + C}
\]

4. Specificity of the diagnosis \( (Sp) \)

a. Proportion of persons without the disease who are correctly diagnosed as not having the disease

\[
Sp = \frac{True (\text{-})}{True \text{ well}} = \frac{D}{B + D}
\]

5. Predictive value of a positive test \( (PVP) \)

a. Proportion of those who test positive for the disease (i.e., are diagnosed as having the disease) who truly have the disease
\[ PVP = \frac{True (+)}{Test (+)} = \frac{A}{A + B} \]

b. Can also be derived using the following formula:

\[ PVP = \frac{Se (Pd)}{Se (Pd) + (1 - Sp) (1 - Pd)} \]

where, PVP, Se, Pd, and Sp are as previously defined

6. Example - Malaria

a. 1,000 persons visit a health clinic because they have a high fever

b. The health worker is to make a diagnosis based on the signs and symptoms and then treat the patients accordingly

<table>
<thead>
<tr>
<th>TRUE DIAGNOSIS</th>
<th>Malaria (+)</th>
<th>No malaria (−)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health worker diagnosis based on signs and symptoms</td>
<td>Positive</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>950</td>
</tr>
</tbody>
</table>

c. Sensitivity (Se)

\[ Se = \frac{True (+)}{True sick} = \frac{A}{A + C} = \frac{40}{50} = 0.80 = 80\% \]

d. Specificity (Sp)

\[ Sp = \frac{True (−)}{True well} = \frac{D}{B + D} = \frac{285}{950} = 0.30 = 30\% \]

e. Prevalence of positive test (Pt; health worker (+))

\[ Pt = Pd (Se) + (1 - Pd) (1 - Sp) = 0.05 (0.80) + (1 - 0.05) (1 - 0.30) = 0.705 = 70.5\% \]
f. Predictive value of positive test (PVP)

\[
PVP = \frac{Se(Pd)}{Se(Pd) + (1 - Sp)(1 - Pd)}
\]

\[
PVP = \frac{0.80(0.05)}{0.80(0.05) + (1 - 0.30)(1 - 0.05)} = \frac{0.04}{0.705} = 0.0567 = 5.7\%
\]

C. Estimate compliance of health worker (\(C_{hw}\)) with desired treatment

1. How likely are health workers to give proper care (as defined by a physician) assuming the disease has been correctly diagnosed

2. Usually derived from local research studies

D. Estimate compliance of patients (\(C_p\)) with the prescribed preventive or therapeutic treatments or procedures

1. How likely are patients to comply with the recommendations and treatment given by the health worker

2. Usually derived from local research studies

E. Estimate level of coverage (\(C_v\)) in the community

1. Is care being offered to all in the community who could theoretically benefit from prevention or therapeutic treatments or procedures

2. Usually derived from local research studies

F. Compute an estimate of community effectiveness (CE) for the prevention or intervention program or procedure

1. Derive estimates for the following five parameters, expressing each as a proportion between 0 and 1

   a. Efficacy (E)

   b. Sensitivity (Se)

   c. Compliance by health workers (\(C_{hw}\))

   d. Compliance by patients (\(C_p\))

   e. Coverage of community (\(C_v\))