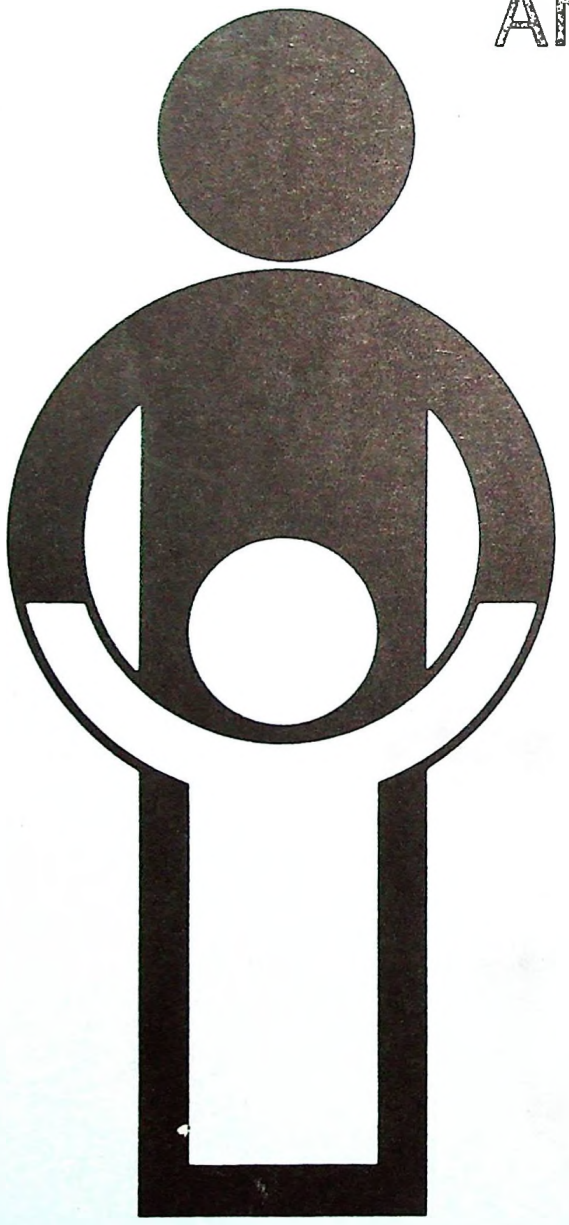
Gill Tremlett.

EXPANDED PROGRAMME ON IMMUNIZATION

TRAINING COURSE ON PLANNING AND MANAGEMENT

GILL TREMLETT



Disease Estimates: Measles

WORLD HEALTH ORGANIZATION

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MEASLES

INTRODUCTION

Measles is an infectious disease characterized by rash, fever, and cough. It is particularly severe in many developing countries and is one of the major causes of childhood mortality in some countries.

To estimate the importance of measles in a country, the following steps should be performed:

1.0 Estimate the annual incidence and incidence rate of measles.

2.0 Estimate the annual mortality and mortality rate of measles.

3.0 Estimate the frequency of various types of disability from measles.

4.0 Determine if seasonal variations occur in the incidence of measles.

This booklet provides detailed guidelines for performing each of these steps. It also includes practice exercises which require you to perform the steps using data on Fictitia. Fold out pages M-19 to M-23, which contain selected data on measles for Fictitia. You will use these data to complete the exercises in the booklet. Do not read through the entire booklet first, but complete the exercises and fill in the data for Fictitia as you go along.

1.0 ESTIMATE THE ANNUAL INCIDENCE AND INCIDENCE RATE OF MEASLES.

The incidence of measles is the number of new cases of the disease in a defined population during a given time period (for example, one year). The incidence rate of measles is the frequency of new cases of the disease in a defined population during a given time period. Incidence rate of measles is expressed as the number of new cases of the disease per 100,000 population.

Serologic surveys have shown that in almost every country without an immunization programme, virtually every child gets measles. Therefore, the average annual incidence of the disease approximates the number of live births minus the number of children who die before they get measles. In other words, if the infant mortality rate is 100 per 1000 live births, 90% of the live births would survive to one year of age, after which they would be likely to get measles.

The procedures for estimating the annual incidence rate and incidence of measles are described below.

Annual Incidence Rate Per 100,000 Population:

- Birth rate x Percent of live births surviving to 1 year x 100,000 = Annual incidence rate

Annual Incidence:

- Annual incidence rate ÷ 100,000 x Population = Annual incidence

Exercise A

In this exercise you will estimate the annual incidence rate of measles in Fictitia. You will then use this rate to estimate the annual incidence of measles in the country as a whole and in the Delta Region of the country.

- Read and follow the instructions carefully.
- Write your answers in the spaces provided.
- When you need data, refer to page M-19 in this booklet.
- If you have questions, consult with a Course Facilitator.

1. To estimate the annual incidence rate of measles per 100,000 population in Fictitia:

   a. Record the birth rate in Fictitia (expressed as a decimal). 0.04

   b. Record the percent of live births surviving to one year (expressed as a decimal). 0.9

   c. Multiply your answer to (a) times your answer to (b).

   $\underset{(a)}{0.04} \times \underset{(b)}{0.9} = 0.036$

   d. Multiply your answer to (c) times 100,000.

   $\underset{(c)}{0.036} \times 100{,}000 =$ 3600 cases per 100,000 pop. pa.

2. To estimate the annual incidence of measles in Fictitia:

   a. Record the annual incidence rate of measles per 100,000 population in Fictitia (from Step 1d). 3600

   b. Divide your answer to (a) by 100,000.

   $\underset{(a)}{3600} \div 100{,}000 = 0.036$

   c. Record the total population in Fictitia. 16 M.

   d. Multiply your answer to (b) times your answer to (c).

   $\underset{(b)}{0.036} \times \underset{(c)}{16 \times 10^6} = 576000$

3. To estimate the annual incidence of measles in the Delta Region:

   a. Record the annual incidence rate of measles per 100,000 population in Fictitia (from Step 1d). 3600

   b. Divide your answer to (a) by 100,000.

   3600 (a) ÷ 100,000 = 0.036

   c. Record the total population in the Delta Region. 1M

   d. Multiply your answer to (b) times your answer to (c).

   0.036 (b) x 10^6 (c) = 36000.

Exercise B

In this exercise you will compare the estimated annual incidence of measles in each region of Fictitia with the reported annual incidence in each region.

- Read and follow the instructions carefully.
- Write your answers in the spaces provided.
- When you need data, refer to page M-19 in this booklet.
- If you have questions, consult with a Course Facilitator.

1. Record on Table 1, below, the reported annual incidence of measles in each region of Fictitia.

2. Record on Table 1 the estimated annual incidence of measles in the Delta Region (from Exercise A, Step 3d, page M-4). To save you time, the estimated annual incidence of measles for the Coastal, Highland, and Mountain Regions have already been calculated for you and recorded on the table.

3. Calculate "Reporting Completeness" by dividing the reported incidence for each region by the estimated incidence for that region. Then multiply those figures times 100 to convert your answers to percentages. Record these figures on Table 1 in the last column. These figures for reporting completeness reflect the percentage of actual cases of measles reported in each region. For example, if reporting completeness for a region is 8%, this means that only 8% of actual cases of measles in the region are reported.

4. Do some regions seem to have more reliable reporting systems than others? If yes, explain.

TABLE 1: REPORTING COMPLETENESS OF INCIDENCE

Region	Reported Incidence	Estimated Incidence	Reporting Completeness	Rep/Est ×100
Delta	196	36,000	0.0052777	= 0.527%
Coastal	47,000	360,000	0.130555	= 13.05%
Highland	9,900	144,000	0.0687500	= 6.875%
Mountain	140	36,000	0.0038888	= 0.38%

When you have completed Exercise B, discuss your work on Exercises A and B with a Course Facilitator.

2.0 ESTIMATE THE ANNUAL MORTALITY AND MORTALITY RATE OF MEASLES.

A critical factor in determining the significance of measles as a health problem in a country is the mortality resulting from the disease. Because routine reporting of measles mortality is rarely accurate, other methods must be used to estimate mortality. Estimates can be made using outpatient records at sentinel sites, but data obtained from these records will be very rough estimates. Inpatient records are even less useful because they include primarily the more severe cases of measles.

Since measles mortality varies significantly with age, estimates of measles mortality are more accurate when based on age distribution of cases data and age-specific case fatality rates (the percentage of cases that result in death in each age group). In order to make reasonable estimates of age-specific case fatality rates of measles, a group of measles cases in selected areas should be followed for outcome.

If both age-specific case fatality rates and age distribution of cases data are available, the process described below can be used to estimate the annual mortality and mortality rate of measles.

Annual Mortality:

- Annual incidence x Percentage distribution of cases by age = Annual age-specific incidence
- Annual age-specific incidence x Age-specific case fatality rate = Annual age-specific mortality
- Annual mortality for first age group + Annual mortality for all other age groups = Annual mortality

Annual Mortality Rate per 100,000 Population:

- Annual mortality ÷ Population x 100,000 = Annual mortality rate

If either age-specific case fatality rates or age distribution of cases data are not available, estimates of measles mortality can still be made but they will be less accurate. These less accurate estimates can be made if both overall case fatality rates and overall incidence data are available. The following process (page M-7) can be used to make these

less accurate estimates of the annual mortality and mortality rate of measles.

Annual Mortality:

- Annual incidence x Case fatality rate = Annual mortality

Annual Mortality Rate Per 100,000 Population:

- Annual mortality ÷ Population x 100,000 = Annual mortality rate

Exercise C

In this exercise you will estimate the annual mortality and mortality rate of measles in the Delta Region of Fictitia.

- Read and follow the instructions carefully.
- Write your answers in the spaces provided.
- When you need data, refer to pages M-19 and M-21.
- If you have questions consult with a Course Facilitator.

1. To estimate the annual mortality from measles in the Delta Region:

   a. Record the annual incidence of measles in the Delta Region (from Step 3d, page M-4) on Table 2 on page M-9 at the bottom of the column titled "Age-Specific Incidence."

   b. Record the percentage distribution of cases by age in the Delta Region on Table 2 in the column titled "% Distribution by Age." Express each percentage as a decimal. These percentages can be obtained from studies of outpatient records. If percentages are available only for the entire country or for a region in Fictitia other than the Delta Region, assume that those percentages also apply to the Delta Region.

   c. Multiply the percent of cases in children aged 0-2 months (in the column titled "% Distribution by Age") times the annual incidence of measles (at the bottom of the column titled "Age-Specific Incidence"). Record this figure in the column titled "Age-Specific Incidence."

   d. Repeat Step (c) above, for the remaining age groups and record your answers in the column titled "Age-Specific Incidence."

   e. Record the age-specific case fatality rates for measles in the Delta Region on Table 2 in the column titled "Age-Specific Case Fatality Rate." Express the rates as decimals. These rates can be obtained from studies of outpatient records. If rates are available only for the entire country or for a region in Fictitia other than the Delta Region, assume that those rates also apply to the Delta Region.

   f. Multiply the age-specific incidence for the 0-2 month age group (in the column titled "Age-Specific Incidence") times the case fatality rate for the 0-2 month age group (in the column titled "Age-Specific Case Fatality Rate"). Record your answer in the last column titled "Age-Specific Mortality."

   g. Repeat Step (f) for the remaining age groups and record your answers in the column titled "Age-Specific Mortality."

   h. Add the figures in the column titled "Age-Specific Mortality," and record your answer at the bottom of that column.

TABLE 2: AGE DISTRIBUTION OF MEASLES INCIDENCE AND MORTALITY IN THE DELTA REGION OF FICTITIA

Age	% Distribution By Age	Age-Specific Incidence	Age-Specific Case Fatality Rate	Age-Specific Mortality
0-2 mos.	0		—	0
3-8 mos.	0		4% 0.04	0
9-14 mos.	0.20	7200	5% 0.05	360
15-35 mos.	0.40	14400	3% 0.03	432
3 yrs +	0.40	14400	1% 0.01	144
Total	1.00	36000	0.13	936

2. To estimate the annual mortality rate of measles per 100,000 population in the Delta Region:

   a. Record the total annual mortality from measles in the Delta Region (from Table 2). 936.

   b. Record the population in the Delta Region. 1,000,000

   c. Divide your answer to (a) by your answer to (b).

   $$\underset{(a)}{936} : \underset{(b)}{10^6} = 0.000936$$

   d. Multiply your answer to (c) times 100,000.

   $$\underset{(c)}{0.000936} \times 100{,}000 = 93.6$$

3. Fold out page M-11. Table 3 contains data on the distribution of measles incidence and mortality in the Coastal, Highland, and Mountain Regions. Table 4 contains data on the mortality rate of measles in each of these regions. All figures on these two tables were calculated using the same process described in Steps 1 and 2 for the Delta Region.

   Using your calculations for the Delta Region and the tables on page M-11, compare the percentage distribution of cases among the 4 regions of Fictitia. Are there any differences? If so, explain in the space below why you think these differences exist.

DISEASE ESTIMATES: MEASLES

TABLE 3: AGE DISTRIBUTION OF MEASLES INCIDENCE AND MORTALITY

Age	DELTA REGION				COASTAL REGION				HIGHLAND REGION				MOUNTAIN REGION			
	% Distribution by Age	Age-specific Incidence	Age-specific Case Fatality Rate	Age-specific Mortality	% Distribution by Age	Age-specific Incidence	Age-specific Case Fatality Rate	Age-specific Mortality	% Distribution by Age	Age-specific Incidence	Age-specific Case Fatality Rate	Age-specific Mortality	% Distribution by Age	Age-specific Incidence	Age-specific Case Fatality Rate	Age-specific Mortality
0-2 mos.	0	—	—	—	---	--	--	--	--	--	--	--	--	--	--	--
3-8 mos.	0	—	—	—	0.20	72,000	0.04	2,880	0.10	14,400	0.04	576	--	--	0.04	--
9-14 mos.	0.20	7200	0.05	360	0.50	180,000	0.05	9,000	0.30	43,200	0.05	2,160	0.10	3,600	0.05	180
15-35 mos.	0.30	10,800	0.03	324	0.30	108,000	0.03	3,240	0.40	57,600	0.03	1,728	0.40	14,400	0.03	432
3 yrs. +	0.20	7200	0.01	72	--	--	0.01	--	0.20	28,800	0.01	288	0.50	18,000	0.01	180
TOTAL	1	3600	--	936	--	360,000	--	15,120	--	144,000	--	4,752	--	36,000	--	792

occurs later

TABLE 4: MEASLES MORTALITY

Region	Mortality	Population	Mortality Rate*
Delta	936	1000,000	93.6
Coastal	15,120	10,000,000	151.2
Highland	4,752	4,000,000	118.8
Mountain	792	1,000,000	79.2
TOTAL	21,600	16,000,000	135

*per 100,000 population

Exercise D

In this exercise you will compare the estimated annual mortality from measles in each region of Fictitia with the reported annual mortality in each region.

- Read and follow the instructions carefully.
- Write your answers in the spaces provided.
- When you need data, refer to page M-19 in this booklet.
- If you have questions, consult with a Course Facilitator.

1. Record on Table 5 on the next page, the reported annual mortality from measles in each region of Fictitia.

2. Record on Table 5 the estimated annual mortality from measles in the Delta Region (from Exercise C, Step 1h, page M-8). To save you time, the estimated annual mortality from measles for the Coastal, Highland, and Mountain Regions have already been calculated for you and recorded on the table.

3. Calculate "Reporting Completeness" by dividing the reported mortality for each region by the estimated mortality for that region. Then multiply those figures times 100 to convert your answers to a percentage. Record these figures on Table 5 in the last column. These figures for reporting completeness reflect the percentage of actual deaths from measles that are reported in each region. For example, if reporting completeness for a region is 2%, this means that only 2% of actual deaths from measles in the region are reported.

4. Do some regions seem to have more reliable reporting systems than others? If yes, explain.

5. Compare reporting completeness of measles <u>incidence</u> in Fictitia (from page M-5) with reporting completeness of measles <u>mortality</u> in the country. Are there any differences? If so, explain in the space below why you think these differences exist.

TABLE 5: REPORTING COMPLETENESS OF MORTALITY

Region	Reported Mortality	Estimated Mortality	Reporting Completeness
Delta	150	936	16.02 %
Coastal	2,855	15,120	20.17 %
Highland	1,801	4,752	38.74 %
Mountain	125	792	15.78 %

→ better

Easier to report mortality than morbidity

lower deaths in older children.

Morbidity recording better in HC.

Mort " " " H.

When you have completed Exercise D, discuss your work on Exercises C and D with a Course Facilitator.

3.0 ESTIMATE THE FREQUENCY OF VARIOUS TYPES OF DISABILITIES FROM MEASLES.

Measles sometimes results in serious short- and long-term disabilities, such as pneumonia, damage to one or both eyes or ears, and under-nutrition (especially kwashiorkor). The frequency of disability, although difficult to determine accurately, is a factor which contributes to the importance of measles as a health problem.

Disability data can best be obtained from a longitudinal follow-up study of measles cases. Since these disabilities are rarely, if ever, reported as measles-related, and since they also often occur not associated with measles, routine reporting systems are not useful in determining the frequency of disability from measles.

In addition, because persons with the more severe disabilities are more likely to seek medical attention, estimates based on hospital and clinic data are falsely high.

Exercise E

In this exercise you will estimate the frequency of disability from measles in Fictitia.

- Read and follow the instructions carefully.
- Write your answers in the spaces provided.
- When you need data, refer to page M-21 in this booklet.
- If you have questions, consult with a Course Facilitator.

1. Have any longitudinal follow-up studies of measles cases been conducted in Fictitia?

   - If no, go to Step 2.
   - If yes, list the major types of disabilities.

   pneumonia
   eyes
   ears
   Malnutrition
   pneumonia/dehydration.

   pneumonia
   diarrhoea
   malnutrition
   Otitis
   Otitis/deafness
   CNS complications

   Is the rate of disabilities from measles in the study high (≥ 30%), moderate (15-29%), or low (≤ 15%)?

2. Is any other information available on measles disability in Fictitia?

   - If no, go to Step 3.
   - If yes, summarize the information.

3. Use the information from Steps 1-2 to determine if the rate of disabilities from measles in Fictitia is high (≥ 30%), moderate (15-29%), or low (≤ 15%).

4.0 DETERMINE IF SEASONAL VARIATIONS OCCUR IN THE INCIDENCE OF MEASLES.

Having as much information as possible about differences in measles incidence at various times of the year will increase the chances that efforts are directed where and when they can have the greatest impact. For example, if a programme manager knows when measles incidence is greatest, he or she can conduct a periodic measles immunization programme before the transmission season, rather than during or after. If information is available from sentinel reports in the country in which you are working or in a similar country, it should be compiled for consideration when planning an immunization programme.

Exercise F

In this exercise you will determine if seasonal variations occur in measles incidence in Fictitia.

- Read and follow the instructions carefully.
- Write your answers in the spaces provided.
- When you need data, refer to page M-23.
- If you have questions, consult with a Course Facilitator.

Have measles reports from sentinel sites, particular regions, or the country as a whole been compiled on a monthly or quarterly basis?

- If no, consider how monthly or quarterly reports could be compiled to provide data.
- If yes, do the reports suggest any seasonal patterns in measles incidence? If so, describe these patterns in the space below.

Measles peaks in 2nd half of dry season
drops at beginning of wet season
Deaths highest at 2nd half of dry season
Higher death in rainy season ? less food
? less care

CONCLUSION

This booklet has described procedures for estimating the incidence and mortality of measles, the frequency of various types of disability from measles, and seasonal variations which occur in the incidence of measles. These estimates can be used to plan an effective immunization programme. Once a programme is operating, these estimates can be used to evaluate that programme's success in preventing measles.

The Annex to this booklet, which begins on page M-25, contains extra copies of guidelines for estimating the incidence and mortality of measles. These guidelines can be used to estimate the impact of the disease in your country.

When you have completed this booklet on measles, discuss your work on Exercises E and F with a Course Facilitator.

Annual Birth Rate

40/1000 population or 0.04

Infant Mortality Rate (< 1 year old)

100/1000 live births or 0.10

Population of Fictitia

REGION	POPULATION
Delta	1,000,000
Coastal	10,000,000
Highland	4,000,000
Mountain	1,000,000
Total	16,000,000

Reported Data on Measles

In 1980, the following reports of measles cases and deaths were received by the Ministry of Health.

REGION	CASES	DEATHS
Delta	190	150
Coastal	47,000	3,050
Highland	4,900	1,841
Mountain	140	125

--continued

Selected Data on Fictitia, continued

Survey to Determine Age Distribution of Measles Cases and Age-Specific Case Fatality Rates

Thirty village outbreaks of measles were investigated in each of the 4 regions of Fictitia to determine the age distribution of measles cases. The results are summarized in the following table:

Percent Distribution by Age*

Age	Delta	Coastal	Highland	Mountain
0-2 months	0.00	0.00	0.00	0.00
3-8 months	0.00	0.20	0.10	0.00
9-14 months	0.20	0.50	0.30	0.10
15-35 months	0.40	0.30	0.40	0.40
3 years +	0.40	0.00	0.20	0.50

*expressed as a decimal

During 1977 and 1978 the Department of Community Medicine of the Fictitia Teaching Hospital carried out a follow-up of 500 cases of measles. It was found that 17 cases had died. The age distribution of cases and deaths was as follows:

Age	Cases	Deaths	Case Fatality Rate
0-2 months	0	0	-
3-8 months	50	2	4%
9-14 months	150	8	5%
15-35 months	200	6	3%
36 + months	100	1	1%
TOTAL	500	17	3%

Among the 483 survivors, 150 (or 31%) had one or more of the following disabilities related to the measles episode:

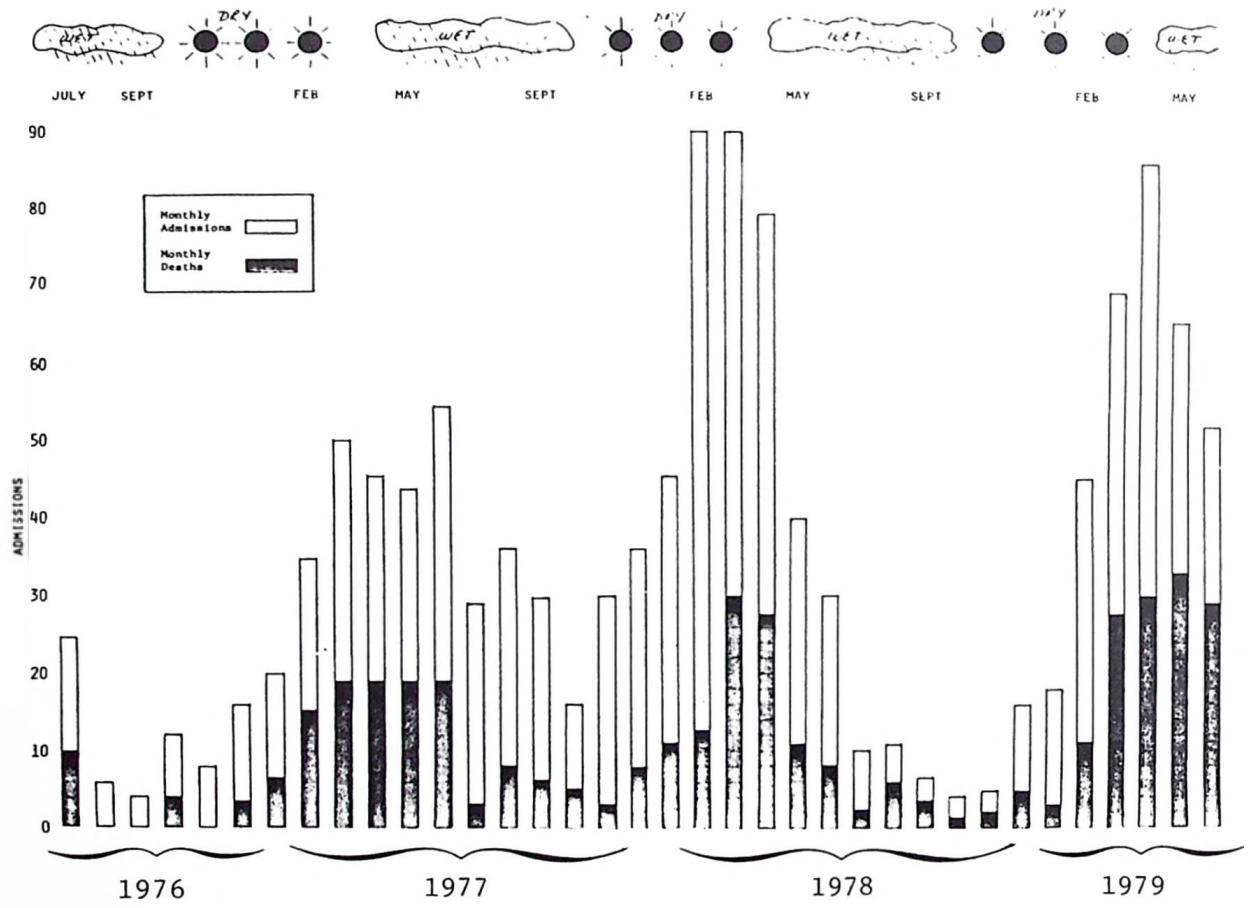
Disability	Frequency
Pneumonia	58
Dehydration	54
Undernutrition	35
Otitis	18
Ocular damage	5
Central Nervous System complications	1

--continued

Selected Data on Fictitia, continued

Seasonal Variations in the Incidence of Measles

The records of the Cualkyer Hospital were reviewed for the period July 1976 - June 1979 for monthly measles admissions and deaths.



ANNEX:

EXTRA COPIES OF GUIDELINES FOR ESTIMATING
INCIDENCE AND MORTALITY OF MEASLES

NOTE: The guidelines in this Annex may be adapted for use in planning your country's immunization programme.

GUIDELINES FOR ESTIMATING ANNUAL INCIDENCE
AND INCIDENCE RATE OF MEASLES

1. Annual incidence rate of measles per 100,000 population in a country:

   a. Record the birth rate in the country (expressed as a decimal). _____

   b. Record the percent of live births surviving to one year of age (expressed as a decimal). _____

   c. Multiply your answer to (a) times your answer to (b).

   _____ (a) X _____ (b) = _____

   d. Multiply your answer to (c) times 100,000.

   _____ (c) X 100,000 = _____

2. Annual incidence of measles in the country:

   a. Record the annual incidence rate of measles per 100,000 population in the country (from Step 1d). _____

   b. Divide your answer to (a) by 100,000.

   _____ (a) ÷ 100,000 = _____

   c. Record the population in the country. _____

   d. Multiply your answer to (b) times your answer to (c).

   _____ (b) X _____ (c) = _____

3. Annual incidence of measles in a region of the country:

   a. Record the annual incidence rate of measles per 100,000 population in the country (from Step 1d). _____

   b. Divide your answer to (a) by 100,000.

   _____ (a) ÷ 100,000 = _____

   c. Record the total population in the region. _____

   d. Multiply your answer to (b) times your answer to (c).

   _____ (b) X _____ (c) = _____

GUIDELINES FOR ESTIMATING ANNUAL MORTALITY
AND MORTALITY RATE OF MEASLES

Use the following process if both age-specific case fatality rates and age distribution of cases data are available.

1. Annual mortality from measles in a region:

   a. Record the annual incidence of measles in the region at the bottom of the column titled "Age-Specific Incidence."

   b. Record the percentage distribution of cases by age in the region. Express each percentage as a decimal.

   c. Multiply the percent recorded for the first age group times the annual incidence in the region. Record this figure in the column titled "Age-Specific Incidence."

   d. Repeat Step (c) for the other age groups.

   e. Record the age-specific case fatality rates for measles in the region. Express each percentage as a decimal.

   f. Multiply the age-specific incidence for the first age group times the case fatality rate for that age group to estimate age-specific mortality for that age group. Record your answer in the column titled "Age-Specific Mortality."

   g. Repeat Step (f) for the other age groups.

   h. Add the age-specific mortality for all age groups to estimate annual mortality from measles in the region. Record your answer at the bottom of the column titled "Age-Specific Mortality."

Age	% Distribution by Age	Age-Specific Incidence	Age-Specific Case Fatality Rate	Age-Specific Mortality
0-2 months				
3-8 months				
9-14 months				
15-35 months				
3 years +				
TOTAL				

2. Annual mortality from measles in a country:

   a. Add the annual mortality from measles in each region in the country. _____

3. Annual mortality rate of measles per 100,000 population in a region:

   a. Record the total annual mortality from measles in the region (from Step 1h, page M-27). _____

   b. Record the population in the region. _____

   c. Divide your answer to (a) by your answer to (b).

   _____ (a) ÷ _____ (b) = _____

   d. Multiply your answer to (c) times 100,000.

   _____ (c) x 100,000 = _____

4. Annual mortality rate of measles per 100,000 population in a country:

   a. Record the annual mortality from measles in the country (from Step 2, page M-27). _____

   b. Record the total population in the country. _____

   c. Divide your answer to (a) by your answer to (b).

   _____ (a) ÷ _____ (b) = _____

   d. Multiply your answer to (c) times 100,000.

   _____ (c) x 100,000 = _____

Use the following process if <u>either</u> age-specific case fatality rates <u>or</u> age distribution of cases data are not available.

1. Annual mortality from measles in a region:

   a. Record the annual incidence of measles in the region. _____

   b. Record the case fatality rate in the region. _____

   c. Multiply your answer to (a) times your answer to (b).

   _____ (a) x _____ (b) = _____

2. Annual mortality from measles in a country:

   a. Add the annual mortality from measles in each region in the country. _____

3. Annual mortality rate per 100,000 population in a region:

   a. Record the annual mortality from measles in the region. _____

   b. Record the population in the region. _____

   c. Divide your answer to (a) by your answer to (b)

   _____ (a) ÷ _____ (b) = _____

   d. Multiply your answer to (c) times 100,000.

   _____ (c) x 100,000 = _____

4. Annual mortality rate per 100,000 population in a country:

   a. Record the annual mortality from measles in the country. _____

   b. Record the population in the country. _____

   c. Divide your answer to (a) by your answer to answer to (b).

   _____ (a) ÷ _____ (b) = _____

   d. Multiply your answer to (c) times 100,000.

   _____ (c) x 100,000 = _____