HEALTH OF MANKIND

Ciba Foundation 100th Symposium

Edited by
GORDON WOLSTENHOLME
and
MAEVE O'CONNOR

J. & A. CHURCHILL LTD.
104 GLOUCESTER PLACE
LONDON, W.1 1967

HEALTH OF MANKIND

HEALTH OF MANKIND

Ciba Foundation 100th Symposium

Edited by
GORDON WOLSTENHOLME
and
MAEVE O'CONNOR

J. & A. CHURCHILL LTD.
104 GLOUCESTER PLACE
LONDON, W.1 1967

With 38 illustrations

Standard Book Number 7000 1318 0

Contents

Manpower and education

Chairman: Sir Eric Ashby

Membership

Symposium on Health of Mankind held 8th-10th March, 1967

The Rt. Hon. Lord Adrian	Trinity College, University of Cambridge
Sir Eric Ashby	Clare College, University of Cambridge
A. L. Banks	Department of Human Ecology, University of Cambridge
H. Beer	The League of Red Cross Societies, Geneva
W. I. B. Beveridge	Department of Animal Pathology, University of Cambridge
D. Burkitt	External Scientific Staff, Medical Research Council, London
M. G. Candau	World Health Organization, Geneva
The Rt. Hon. Lord Cohen of Birkenhead	Royal Infirmary, Liverpool
I. Dogramaci	Hacettepe Science Center, Ankara
C. A. Doxiadis	Doxiadis Associates, Athens
K. Evang	The Health Services of Norway, The Royal Norwegian Ministry of Social Affairs, Oslo
G. Fanconi	Zürich
The Rt. Hon. Lord Florey	The Queen's College, University of Oxford
Victoria Garcia	School of Public Health, University of Chile, Santiago, Chile
J. H. de Haas	Department of Health Development, Netherlands Institute for Preventive Medicine, Leiden
P. E. A. Johnson-Marshall	Department of Architecture, University of Edinburgh
L. A. Kaprio	World Health Organization, Copenhagen
H. Katsunuma	Department of Public Health, Faculty of Medicine, University of Tokyo
T. A. Lambo	Department of Psychiatry and Neurology, University of Ibadan
W. H. le Riche	Department of Epidemiology and Biometrics, School of Hygiene, University of Toronto
Patricia J. Lindop	St. Bartholomew's Hospital Medical College, London
A. M.-M. Payne	World Health Organization, Geneva
H. Pequignot	Faculty of Medicine, University of Paris

‡ **G. Pincus**	Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts
A. Querido	Faculty of Medicine, University of Leiden
A. Wolman	The Johns Hopkins University, Baltimore, Maryland
G. E. W. Wolstenholme	Ciba Foundation, London
Sir Norman Wright	British Association for the Advancement of Science, London

‡ Died 22nd August 1967.

The Ciba Foundation

The Ciba Foundation was opened in 1949 to promote international co-operation in medical and chemical research among scientists from all parts of the world. Its house at 41 Portland Place, London, has become a meeting place well known to workers in many fields of science. Every year the Foundation organizes from six to ten three-day symposia and three or four one-day study groups, all of which are published in book form. Many other informal meetings also take place in the house, organized either by the Foundation or by other scientific groups needing a place to meet. In addition, bedrooms are available for visiting scientists, whether or not they are attending a meeting in the building.

The Ciba Foundation owes its existence to the generosity of CIBA Ltd, Basle, who, realizing the disruption of scientific communication caused by the war and by problems of distance, decided to set up a philanthropic institution whose aim would be to overcome such barriers. London was chosen as its site for reasons dictated by the special advantages of English charitable trust law (ensuring the independence of its actions), as well as those of language and geography.

The Foundation's many activities are controlled by a small group of distinguished trustees. Within the general framework of biological science, interpreted in its broadest sense, these activities are well summed up by the Ciba Foundation's motto, *Consocient Gentes*—let the nations come together.

Introduction

More than one hundred meetings of one kind or another are held at the Ciba Foundation each year, but of our own major conferences, each lasting three or four days, the hundredth was held in March 1967, and this book contains the papers and discussions of that occasion.

I use the word "major" from a domestic point of view only: these symposia, which began in January 1950, have been notable for having a severely restricted membership of 30 or less, the intention being to provide at least as much opportunity and time for discussion as for the hearing of prepared papers. The members are always selected entirely on our own responsibility, and inter-disciplinary contact is regarded as being as important as international co-operation.

Most of our symposia have been on research topics of acute interest. Given an excuse such as the 50th symposium, the opening of a new conference room, or a quinquennial birthday, we have allowed ourselves a little eccentricity and have organized meetings on such wide-ranging subjects as "Medical Biology and Etruscan Origins", "Man and his Future", "Man and Africa", and "Conflict in Society". For this 100th symposium we thought we could perhaps be even more foolhardy: I had tried to look at all Africa as one unit—why not attempt now to consider the health of the whole world?

We could assess the total burden of infectious and other physical diseases, the special problems of the care of mother and child, the incidence of mental and behavioural disorders, the injuries of environmental origin, and the relevance of animal diseases to human health. Then there were the factors which aggravate the task of health services: incomparably the greatest is the problem of population growth, but there are also questions of food variety and supply, the pollution of water and air, the inhumanity of cities, and the artificial boundaries produced by politics and traditions. We could consider also the present and anticipated world resources of medical manpower of all kinds, the facilities for education and training, and whether the great work of the World Health Organization might be extended into a World Health Service.

This most ambitious plan could hardly have become a reality if I had not received immediate encouragement from Dr. Candau, Professor Banks and Mr. Beer. Their unhesitating support and promise of personal participation gave me courage to go ahead in this attempt to draw the eyes of man upwards for a while from the prevalent squalor of preventable disease and starvation, and from all man's incomprehensible and continuing cruelty to man. If we cannot work together for the health of mankind, we are rightly doomed. If we can learn to collaborate in all the many aspects of medical care we may also begin to think healthily about race, politics, sovereignty, international use of resources of all kinds, and economic interdependence.

It was perhaps unfair to ask the speakers at this meeting to talk in global terms. But when the time came, they did so with courage and concern. The views expressed are those of individuals, not organizations.

This conference was the completion of a century. It is also a beginning.

G. E. W. WOLSTENHOLME

As this book was about to be printed, the sad news was received of the death of one of its contributors, Dr. Pincus. This symposium proved, therefore, to be the last of many occasions on which Dr. Pincus had joined generously and brilliantly in the Ciba Foundation's activities. We mourn him profoundly as a friend. Those who did not know him personally will nevertheless discern from his contributions to this book his sincere compassion and the tireless intellectual and experimental effort with which he tackled the supreme problem of population growth. His concern was as much for every individual as for the whole of mankind, and such very practical idealism is a striking example of what this publication is intended to encourage.

With all respect and affection this book is now dedicated

TO THE MEMORY OF
GREGORY PINCUS

I

WORLD INCIDENCE AND PREVALENCE OF THE MAJOR COMMUNICABLE DISEASES

W. HARDING LE RICHE
Department of Epidemiology and Biometrics,
School of Hygiene, University of Toronto, Toronto, Canada

"Youth is alive and once we too were young,
Dreamed we could make the world all over new,
Tossed eager projects lightly from the tongue,
And hoped the hurrying years would prove them true."
GAMALIEL BRADFORD: Wellesley at Fifty, 1881–1932.

DURING the last forty years the western world has certainly been made anew as regards its communicable diseases—except, of course, for the common cold and influenza, which are still very much with us, and with the rest of the world as well.

History shows that, particularly in Western Europe, plague almost disappeared in the 17th century, only to have its place taken by typhus and smallpox. In the 19th century typhus was nearly conquered[1] but it fought a rearguard action during the wars of the 20th century. Smallpox and cholera caused widespread confusion and unnumbered deaths in the 19th century. Smallpox has maintained its stronghold in the East and in West Africa, and cholera has retreated to the delta of the Ganges at the present time. Typhoid came into prominence in the 19th century and made the proper disposal of sewage and the provision of pure water supplies an urgent problem for city dwellers. This particular battle is still being waged in many parts of the world.

The major killing diseases in the world today are pneumonia, tuberculosis and the diarrhoeal diseases, but cholera and smallpox remain. Plague is no longer epidemic in its sylvatic or rural form. The most spectacular outbreak of modern times was the great pandemic of influenza that swept across the world in 1918–19 and attacked an estimated 700 million people, killing over 20 million.[1] No doubt this sort of epidemic could happen again because we do not really know how to control such an onslaught.

In large areas of the world insect-borne disease is still a menace. Malaria and yellow fever and trypanosomiasis are by no means conquered and may return in full strength if preventive guards are let down. The discovery of new insecticides has, of course, been of great help in controlling insects, but these chemicals are poisonous to other creatures.

At present we have the technical knowledge required to control many infectious diseases, but we experience increasing difficulty in applying it because of administrative disorganization in many parts of the world. This is bound up with vast population increases, declining food production per head in many developing countries, and the inability of many countries to cope with a rapidly changing technology.

We cannot, of course, take a fatalistic view about these matters, but we should at least be completely realistic. Many people in public health and clinical medicine tend to consider only their own specialities, forgetting that the welfare of mankind is a far more complicated question than the prevention of disease and the care of the sick.

CONCEPTS OF HEALTH AND DISEASE

In discussing matters of health and disease we should keep our feet on the ground, although there is no reason why we should not now and again have our heads in the clouds. The following quotation from Dubos[2] is rather appropriate:

"The hope that disease can be completely eradicated becomes a dangerous mirage only when its unattainable character is forgotten. It can then be compared to a will-o'-the-wisp luring its followers into the swamps of unreality. In particular it encourages the illusion that man can control his responses to stimuli and can make adjustments to new ways of life without having to pay for these adaptive changes. The less pleasant reality is that in an ever-changing world each period and each type of civilization will continue to have its burden of diseases created by unavoidable failures of adaptation to the new environment."

As it is impossible to measure the "health" of a population, the best we can do is to measure "lack of health". The indices based on mortality, such as crude and age-adjusted death rates, infant mortality rates, and expectation of life have traditionally been used as measures of health. Quite clearly, they are crude measures which do not take into consideration anything but the most extreme situation, shown as death. These rates are an uncertain guide to the amount of illness (morbidity) in the community, a matter of greater economic importance than a measure of mortality. In the developed

Table I

POPULATION, RATE OF INCREASE, BIRTH AND DEATH RATES, AREA AND DENSITY FOR THE WORLD, MAJOR DIVISIONS AND REGIONS FOR SELECTED YEARS[6]

(Unless otherwise specified, all figures are estimates of the order of magnitude and are subject to a substantial margin of error)

Major divisions	*Estimates of mid-year population (millions)*						*Rate of population increase** (%)		*Birth rate* (o/oo)	*Death rate* (o/oo)	*Area† km²* (000's)	*Density‡*
	1930	1940	1950	1958	1960	1963	1958–63	1960–63	1958–63	1958–63	1963	1963
WORLD TOTAL	2,070	2,295	2,517	2,875	2,990	3,160	1·8	1·9	34	16	135,761	23
Africa	164	191	222	262	273	294	2·3	2·5	46	23	30,227	10
Northern America§	134	144	166	192	199	208	1·6	1·6	24‖	9‖	21,515	10
Latin America	108	130	163	203	212	231	2·7	2·8	40	14	20,535	11
East Asia¶	591	634	684	772	793	828	1·4	1·4	33	19	11,725	71
South Asia**	529	610	697	826	858	920	2·2	2·4	42	20	15,896	58
Europe††	355	380	392	418	425	437	0·9	0·9	19	10	4,929	89
Oceania§	10·0	11·1	12·7	15·1	15·7	16·8	2·1‡‡	2·2‡‡	27	11	8,532	2
USSR	179	195	180	207	214	225	1·6	1·6	24‖	7‖	22,402	10

* Average annual per cent rate of population increase.
† Comprising land area and inland waters, but excluding uninhabited polar regions and some uninhabited islands.
‡ Population per square kilometre of area.
§ Hawaii, a state of the United States of America, is included in Northern America rather than Oceania.
‖ Weighted average of recorded rates.
¶ Excluding the USSR, shown separately below.
** Excluding the USSR, shown separately, but including both the Asian and European portions of Turkey.
†† Excluding the USSR, shown separately below, and the European portion of Turkey, which is included in South Asia.
‡‡ Rate reflects effect of natural increase and migration.

parts of the world we do have some morbidity statistics. These include notifications of infectious disease, with the clear limitations of such data; hospital separations, which give only a partial picture of disease episodes; and some special studies, such as the records of general practitioners or the records of medical insurance plans, that give an estimate of work carried out by physicians. The best general picture of the health of a community is provided by health surveys, such as the National Health Survey of the United States[3], the United Kingdom Survey of Sickness[4] and others. These surveys have the limitation that the diagnoses are those reported by patients rather than by physicians. The whole complex matter of the conceptual problems in the developing of an index of health has been discussed by Sullivan[5], to whose work reference should be made for additional information. Its concepts are applicable only in the developed countries of the world where it is possible to carry out sampling and other surveys of the health of the population.

WORLD POPULATIONS AND GEOGRAPHICAL AREAS

It is sound epidemiological practice to define the population at risk and this information is given in Table I, for the years 1930 to 1963. Only major geographical subdivisions are mentioned, with data derived from the United Nations Demographic Yearbook, shown in Tables I[6] and II[6].

Table II

COMPOSITION OF WORLD REGIONS[6]

AFRICA

Western Africa
- Cape Verde Islands
- Dahomey
- Gambia
- Ghana
- Guinea
- Ivory Coast
- Liberia
- Mali
- Mauritania
- Niger
- Nigeria
- Portuguese Guinea
- St. Helena (including dependencies)
- Senegal
- Sierra Leone
- Togo
- Upper Volta

Eastern Africa
- Burundi
- Comoro Islands
- Ethiopia
- French Somaliland
- Kenya
- Madagascar
- Malawi
- Mauritius
- Mozambique
- Réunion
- Rwanda
- Seychelles
- Somalia
- Southern Rhodesia
- Uganda
- United Republic of Tanzania
- Zambia

Northern Africa
- Algeria
- Ifni
- Libya
- Morocco
- Spanish North Africa
- Spanish Sahara
- Sudan
- Tunisia
- United Arab Republic

Middle Africa
- Angola
- Cameroon
- Central African Republic
- Chad
- Congo (Brazzaville)
- Congo (Democratic Republic of)
- Equatorial Guinea

Table II—Continued

Middle Africa—Cont.
Gabon
São Tomé and Principé

Southern Africa
Basutoland
Bechuanaland
French Southern and Antarctic Territories
South Africa
South West Africa
Swaziland

NORTHERN AMERICA
Bermuda
Canada
Greenland
St. Pierre and Miquelon
United States (including Hawaii)

LATIN AMERICA
Tropical South America
Bolivia
Brazil
British Guiana
Colombia
Ecuador
French Guiana
Peru
Surinam
Venezuela

Middle America (Mainland)
British Honduras
Canal Zone
Costa Rica
El Salvador
Guatemala
Honduras
Mexico
Nicaragua
Panama

Temperate South America
Argentina
Chile
Falkland Islands
Paraguay
Uruguay

Caribbean
Antigua
Bahama Islands
Barbados
Cayman Islands
Cuba
Dominica
Dominican Republic
Grenada
Guadeloupe
Haiti
Jamaica
Martinique
Montserrat
Netherlands Antilles
Puerto Rico
St. Kitts-Nevis and Anguilla
St. Lucia
St. Vincent
Trinidad and Tobago
Turks and Caicos Islands
Virgin Islands (UK)
Virgin Islands (US)

EAST ASIA
Mainland region
China (mainland)
Hong Kong
Macau
Mongolia

Japan

Other East Asia
Bonin Islands
China (Taiwan)
Korea
Ryukyu Islands

SOUTH ASIA
Middle South Asia
Afghanistan
Bhutan
Ceylon
India
Iran
Maldive Islands
Pakistan

Middle South Asia—Cont.
Nepal
Sikkim

South-East Asia
Brunei
Burma
Cambodia
Indonesia
West Irian
Laos
Malaysia
Philippines
Portuguese Timor
Thailand
Viet-Nam

South-West Asia
Aden
Bahrain
Cyprus
Gaza Strip (Palestine)
Iraq
Israel
Jordan
Kuwait
Lebanon
Muscat and Oman
Protectorate of South Arabia
Qatar
Saudi Arabia
Syria
Trucial Oman
Turkey
Yemen

EUROPE
Western Europe
Austria
Belgium
France
Germany, Federal Republic of
Liechtenstein
Luxembourg
Monaco
Netherlands
Switzerland
West Berlin

Southern Europe
Albania
Andorra

Table II—Continued

Southern Europe—Cont.
Gibraltar
Greece
Holy See
Italy
Malta
Portugal
San Marino
Spain
Yugoslavia

Eastern Europe
Bulgaria
Czechoslovakia
East Berlin
Eastern Germany
Hungary
Poland
Romania

Northern Europe
Channel Islands
Denmark
Faeroe Islands
Finland
Iceland

Northern Europe—Cont.
Ireland
Isle of Man
Norway
Svalbard and Jan Mayen Islands
Sweden
United Kingdom

OCEANIA

Australia and New Zealand

Melanesia
British Solomon Islands
New Caledonia
New Guinea
New Hebrides
Norfolk Island
Papua

Polynesia and Micronesia
American Samoa
Canton and Enderbury

Polynesia and Micronesia —Cont.
Christmas Island
Cocos (Keeling) Islands
Cook Islands
Fiji Islands
French Polynesia
Gilbert and Ellice Islands
Guam
Johnston Island
Midway Islands
Nauru
Niue
Pacific Islands
Pitcairn
Tokelau Islands
Tonga
Wake Island
Western Samoa

UNION OF SOVIET SOCIALIST REPUBLICS

Rates of population increase per year (1960–63) range from 2·8 per cent in Latin America, 2·5 per cent in Africa, down to 0·9 per cent in Europe. In these eight areas, the highest death rate, 23 per 1,000, is found in Africa, with South Asia a close second at 20 per 1,000. Many of these figures had to be based on estimates or on inspired guesses.

A LISTING OF COMMUNICABLE DISEASES

A communicable disease is an "illness due to a specific infectious agent or its toxic products, which arises through transmission of that agent or its products from a reservoir to a susceptible host, either directly as from an infected person or animal, or indirectly through the agency of an intermediate plant or animal host, a vector or the inanimate environment."[7]

These diseases are listed in Table III[7], indicating how many of these conditions are currently identifiable. The order relates to the potential danger of the infections, and ranges from the six internationally quarantinable diseases to those that may not be commonly notifiable.

Table III

CLASSIFICATION OF COMMUNICABLE DISEASES[7]

1. *Case report universally required by international sanitary regulations*

Cholera
Plague
Relapsing fever, epidemic louse-borne (*see also* 3B)
Smallpox
Typhus fever, epidemic louse-borne (classical typhus fever)
Yellow fever—mosquito-borne

2. *Case report regularly required wherever the disease occurs*

(A) By telephone, telegraph or other rapid means:

Anthrax
Eastern equine, Western equine, Japanese B, Murray valley, St. Louis } mosquito-borne encephalitis
Diphtheria
Botulism (food poisoning)
Glanders
Gonococcal vulvovaginitis of children
Gonococcal ophthalmia neonatorum
Meningitis, meningococcal
Paratyphoid fever
Poliomyelitis
Psittacosis
Rabies
Scarlet fever
Puerperal fever
Tetanus
Typhoid fever

(B) By most practicable means:

Brucellosis
Chancroid
Conjunctivitis, inclusion
Gonorrhoea (gonococcal urethritis)
Infectious hepatitis
Serum hepatitis
Leprosy
Leptospirosis
Malaria (or 3C)
Measles
Shigellosis
Syphilis, venereal
Trachoma
Trichinosis
Tuberculosis
Typhus fever, endemic flea-borne (murine typhus)
Whooping cough

3. *Selectively reportable in recognized endemic areas*

(A) By telephone, telegraph or other rapid means:

Haemorrhagic fever with renal syndrome (unknown, mite?)
Argentinian, Bolivian } haemorrhagic fevers
Scrub typhus

(B) By most practical means:

Russian spring-summer encephalitis, Diphasic meningoencephalitis, Louping ill, Powassan encephalitis } tick-borne encephalitis
Bunyamwera, Bwamba, Chikungunya, Mayaro, O'nyong-nyong, Rift Valley, Venezuelan equine, West Nile, Group C viral fevers } mosquito-borne viral fever
Colorado tick fever
Crimean haemorrhagic fever, tick-borne
Omsk haemorrhagic fever, Kyasanur Forest disease } tick-borne
Bartonellosis
Chickenpox in adults where smallpox is infrequent (*see also* 5)
Coccidioidomycosis
Echinococcosis (hydatidosis)
Granuloma inguinale
Histoplasmosis
Leishmaniasis, cutaneous
Leishmaniasis, visceral (kala azar)
Meningitis, aseptic
Paragonimiasis
Pinta
Q fever
Relapsing fever, endemic tick-borne (*see also* 1)
Rheumatic fever
Rocky Mountain spotted fever
Boutonneuse fever
Queensland tick typhus
North Asian tick-borne rickettsiosis
Rickettsial pox
Syphilis, non-venereal (Bejel, Dichuchwa, Njovera, Sibbens, Radesyke)
Trypanosomiasis, African
Trypanosomiasis, American
Tularaemia
Yaws

(C) Collective report weekly by mail:

Amoebiasis
Clonorchiasis
Dracontiasis
Fasciolopsiasis
Filariasis
Hookworm disease
Loiasis
Lymphogranuloma venereum
Malaria (or 2B)
Onchocerciasis
Sandfly fever (phlebotomus-borne)
Schistosomiasis (bilharziasis)
Strongyloidiasis
Toxoplasmosis

4. *Obligatory report of epidemics. No case report required*

Dengue fever
Haemorrhagic fevers of the Philippines and South-east Asia
Conjunctivitis, acute bacterial
Diarrhoea of early childhood
Epidemic diarrhoea in nurseries for the newborn
Food poisoning (a) Salmonellosis
(b) Staphylococcal
(c) Clostridium perfringens
Herpangina
Influenza
Keratoconjunctivitis, infectious
Mononucleosis, infectious
Pleurodynia
Pneumonia, pneumococcal
Pneumonia, bacterial (other than pneumococcal)
Pneumonia, mycoplasmal (PPLO)
Rat-bite fever, streptobacillus moniliformis disease (Haverhill fever)
Acute febrile respiratory disease
Ringworm of scalp (tinea capitis)
Ringworm of body (tinea corporis)
Rubella
Scabies
Staphylococcal disease in the community
Streptococcal disease, haemolytic; streptococcal sore throat; erysipelas

5. *Official report not ordinarily justifiable*

Actinomycosis
Ascariasis
Aspergillosis
North American blastomycosis
Candidiasis
Cat scratch fever
Chickenpox (*see also* 3B)
Chromoblastomycosis
Cryptococcosis
Diphyllobothriasis
Enterobiasis
Larva migrans, visceral
Listeriosis
Lymphocytic choriomeningitis
Mumps
Mycetoma
Nocardiosis
Paracoccidioidal granuloma
Pediculosis
Common cold
Ringworm of foot (tinea pedis)
Ringworm of nails (tinea unguium)
Sporotrichosis
Taeniasis and cysticercosis
Trichomoniasis
Trichuriasis

INCIDENCE AND PREVALENCE

In this paper we clearly need a discussion of the measures of frequency of disease. One of these measures is that of incidence, the occurrence of events during a given period of time in a certain population. This incidence, attack or inception rate may be expressed as follows[8, 9]:

$$\frac{\text{Number of new cases beginning during a defined period of time}}{\text{Average number in a defined population exposed to risk during that time}} \times 1{,}000$$

For instance, in the Canadian Sickness Survey 1950–51[10] a similar definition for incidence was used:

"Incidence is measured by the number of new illnesses commencing during the survey year and the number of persons reporting these illnesses. A new illness is any reported disturbance of health independent of any preceding illness. (Acute and infectious diseases were always treated as new illnesses. They were composed of the following numbers in the International Classification: 040–108, 470, and 480–483). Other illnesses, i.e. those reported as recurring attacks of previous illnesses, thus are not counted in the incidence of illness."

Incidence may of course be counted either in terms of new illnesses (spells of illness, sickness episodes) or in terms of persons reporting new illnesses. Particularly with the common cold and upper respiratory illnesses one person may have a number of new episodes of the same condition during the year under study. For instance, in the Canadian Sickness Survey under the heading "Illness Commencing in Survey Year", which is an expression of incidence, the rate in "Common Colds" for "persons" came to 398·8, but for "illnesses" the figure was 659·9, per 1,000 population at risk, meaning that each person started about two episodes of colds during the study year.

The meaning of the word "prevalence" has not always been clearly stated in surveys or studies. The "point prevalence rate" is commonly expressed as[8, 11, 12]:

$$\frac{\text{Number of cases ill at one point in time}}{\text{Defined population exposed to risk at that time}} \times 1{,}000$$

The "period prevalence rate" is a rather more difficult concept, because it embraces both "point prevalence" at the start of the study period and a more recent incidence.

In the Canadian Sickness Survey prevalence was defined as follows:

"Prevalence thus concerns illnesses (both new and recurring) which commenced at some time prior to the beginning of the Survey and which had not yet terminated at the time the Survey began. It is, therefore, a point prevalence, the point being the beginning of the Survey."[10]

In this Survey both "Persons reporting illness" and "Illnesses reported", are in the table on prevalence. For instance, under "Prevalence" the rate per 1,000 population for persons reporting illnesses (all causes) was 85, while for "illnesses reported (all causes)" the figure was 98, indicating that there was a slight excess of "illnesses" over persons at the beginning of the review period. This is due to the fact that one person may have two illnesses, such as a man with a fractured arm also developing pneumonia.

Both birth and death rates are examples of incidence in that each measures the frequency of a phenomenon per unit of time in a given mean population. They are also a measurement of something that is a new event or experience to each and every one of us. These rates are known reasonably well for most parts of the world. Illness or morbidity is much more difficult to determine.

For certain communicable diseases notifications provide some measurement of new cases. But notifications are not complete, even in the most highly developed countries. Stocks[13] examined the completeness of notification of certain communicable diseases in England and Wales, reaching the following conclusions:

Acute poliomyelitis Cerebro-spinal fever Diphtheria Scarlet fever	Notification is fairly complete
Respiratory tuberculosis	Probably nine-tenths notified
Typhoid and paratyphoid fevers	Probably four-fifths notified
Measles	About two-thirds notified
Pneumonia	From a third to a quarter notified
Whooping cough	From a quarter to a fifth notified
Erysipelas Non-respiratory tuberculosis	Defective to an indeterminate degree
Dysentery	Notification only fractional

Quite clearly, notification is far from adequate as a means of collecting data concerning the incidence of infectious diseases. A much more satisfactory method was introduced in the United States in 1957 when the

National Health Survey began monthly collections of material on current illness from a representative sample of that population[3].

One of the objectives in a study of incidence and prevalence is to develop some idea of persons ill with certain diseases, relative to the number who die from that particular condition. Tables IVa and IVb show, for Ontario 1963[14, 15, 16], the number of hospital separations and persons ill on one or more occasions per death during the year, and their relationships to the corresponding numbers of deaths. This is the kind of information that one would like for the whole world, but which is at present only available in countries with many data on morbidity. From the Ontario figures we may conclude, for instance, that for each death in the total grouping of diseases

Table IVa

PERSONS SICK DURING YEAR COMPARED WITH HOSPITAL SEPARATIONS AND MORTALITY, IN ONTARIO, 1963[14, 15, 16]

(Rates per 1,000 population)

Diagnostic group	*Rates*		
	Mortality[14]	*Hospital separations*[15]	*Persons sick during year*[16]
VII Diseases of the circulatory system	3·452	12·1	103·34
II Neoplasms	1·404	8·4	30·75
VI Diseases of the nervous system and sense organs	1·016	6·9	155·35
XVII Accidents, poisonings, and violence	0·653	13·6	171·20
VIII Diseases of the respiratory system	0·544	24·4	505·88
XIV Congenital malformations XV Certain diseases of early infancy	0·467	1·8	13·61
IX Diseases of the digestive system	0·299	19·7	158·89
XI Deliveries and complications of pregnancy, childbirth and the puerperium	0·297	31·7	40·39
III Allergic, endocrine system, metabolic and nutritional diseases	0·158	3·6	99·53
X Diseases of the genito-urinary system	0·149	13·0	155·60
I Infective and parasitic diseases	0·055	1·5	65·76
XVI Symptoms, senility, and ill-defined conditions	0·026	3·5	131·41
V Mental, psychoneurotic, and personality disorders	0·026	3·3	61·06
IV Diseases of the blood and blood-forming organs	0·025	0·8	33·40
XIII Diseases of the bones and organs of movement	0·024	5·0	91·00
XII Diseases of the skin and cellular tissue	0·010	2·7	145·40
XVIII Supplementary classifications for special admissions, live births, stillbirths, prophylactic inoculations, impairments, blindness, and deafness	0·000	0·9	181·49

Table IVb

ONTARIO 1963: RATIO OF HOSPITAL SEPARATIONS AND PERSONS SICK DURING YEAR TO DEATHS[14, 15, 16]

		Hospital separations per death	*Persons sick during year per death*
VII	Diseases of the circulatory system	4	30
II	Neoplasms	6	22
VI	Diseases of the nervous system and sense organs	7	153
XVII	Accidents, poisonings and violence	21	262
VIII	Diseases of the respiratory system	45	930
XIV, XV	Congenital malformations; Certain diseases of early infancy	4	29
IX	Diseases of the digestive system	66	531
XI	Deliveries and complications of pregnancy, childbirth and the puerperium	107	136
III	Allergic, endocrine system, metabolic and nutritional diseases	23	630
X	Diseases of the genito-urinary system	87	1044
I	Infective and parasitic diseases	27	1196
XVI	Symptoms, senility and ill-defined conditions	135	5054
V	Mental, psychoneurotic, and personality disorders	127	2348
IV	Diseases of the blood and blood-forming organs	32	1336
XIII	Diseases of the bones and organs of movement	208	3792
XII	Diseases of the skin and cellular tissue	270	14,540

of the respiratory system there are 45 hospital separations and 930 persons ill on one or more occasions during the year. For infectious and parasitic diseases the figures come to 27 separations as against 1,196 sick persons. In diseases of the skin and cellular tissue there are 270 separations for each death and 14,540 sick persons. These figures include both new and old episodes of disease and are strictly speaking a combination of incidence and prevalence. Calculations have been made for various parts of the world of notifications per death, which give some idea of new cases (incidence). Such figures have been accepted with many reservations because notifications of certain diseases are not good in the most advanced countries, and are either non-existent or merely misleading in the other parts of the world.

A WORLD ESTIMATE OF DEATHS DUE TO THE LEADING COMMUNICABLE DISEASES

I have attempted here to estimate the number of deaths from the leading communicable diseases[17] in the world (Tables V and VI). This is *not* merely a sum of sporadic and irregular reports from the valiant countries making attempts to assess their vital statistics.

Table V

DEATHS FROM COMMUNICABLE DISEASES

(Estimated World Totals, 1963 (see text for computation))

Cause of death	*Number of deaths in thousands*	*Percentage of deaths from these causes*
1. Pneumonia	5,701	33·12
2. Gastritis, duodenitis, enteritis, and colitis, except diarrhoea of the newborn	3,094	17·97
3. Tuberculosis of respiratory system	2,839	16·49
4. All other diseases classified as infective and parasitic	1,347	7·83
5. Infections of the newborn	1,131	6·57
6. Bronchitis	1,085	6·30
7. Measles	508	2·95
8. Malaria	326	1·90
9. Influenza	313	1·82
10. Dysentery, all forms	202	1·17
11. Smallpox	172	1·00
12. Diphtheria	127	·74
13. Whooping cough	112	·65
14. Typhoid fever	98	·57
15. Syphilis and its sequelae	68	·39
16. Acute poliomyelitis	35	·20
17. Meningococcal infections	31	·18
18. Cholera	12	·07
19. Typhus	7	·04
20. Scarlet fever and streptococcal sore throat	6	·03
21. Plague	0·5	—

Table VI

"ALL OTHER DISEASES CLASSIFIED AS INFECTIVE AND PARASITIC"[17]

030–039	Gonococcal infection and other venereal diseases
040	Paratyphoid fever
042	Other salmonella infections
044	Brucellosis (undulant fever)
049	Food poisoning (infection and intoxication)
052–054	Erysipelas; septicaemia and pyaemia; bacterial toxaemia
059–074	Tularaemia; leprosy; tetanus; anthrax; gas gangrene; other bacterial diseases; Vincent's angina; relapsing fever; leptospirosis; yaws; spirochaetal diseases except syphilis
081–083	Late effects of acute poliomyelitis; acute infectious encephalitis; late effects of acute infectious encephalitis
086–096	Rubella; chicken pox; herpes zoster; mumps; dengue; yellow fever; infectious hepatitis; glandular fever (infectious mononucleosis); rabies; trachoma; other diseases attributable to viruses
120–138	Leishmaniasis; trypanosomiasis; other protozoal diseases; schistosomiasis; other trematode infestations; hydatid disease; other cestode infestations; filariasis; trichiniasis; ankylostomiasis; infestation with worms of other mixed and unspecified type; dermatophytosis; actinomycosis; coccidioidomycosis; other fungus infections; scabies; pediculosis; other arthropod infestation; other infective and parasitic diseases

The countries of the world were divided into eight geographical areas designated as "major divisions", and these were subdivided into "regions", according to the scheme of Table 2 in the United Nations *Demographic Yearbook*, 1964[6] and "Composition of Regions Set Forth in Table 2" (Table II)[6].

The figures for population were taken from the United Nations *Statistical Yearbook*, 1964[18], the mid-year estimates for 1963 for each country of the world being used. These figures formed the basis of all further computations. Totals of populations for major divisions may not coincide exactly with figures quoted from summaries in the United Nations *Demographic Yearbook*, most of which are rounded off to three significant figures. Population data were used as counted or as estimated without taking into account the exceptions and qualifications in the footnotes, since these influenced the overall estimates only slightly.

The United Nations *Demographic Yearbook*, 1964, provided figures for deaths by cause for over a third of the countries of the world, but these were concentrated particularly in Europe and Northern America. Where the records were incomplete values were estimated for a region or a major division based on a ratio of the data from countries or regions reporting to the all-causes mortality for the area. In some instances the same procedure had to be used in order to derive a national figure for a country in which the mortality records related only to certain local populations.

Total estimated deaths were computed from population figures and the death rates per 1,000 as given in Table 2 of the *Yearbook*[6]. Populations by countries were added to give totals for regions, which when multiplied by the estimated death rate gave the estimated number of deaths for that region used throughout this paper. Totals of the regions within a major division multiplied by the United Nations estimated death rate gave the estimated number of deaths for that division—which is therefore not necessarily equal to the sum of deaths in the constituent regions. The total numbers of deaths for Western Africa and for Africa as a whole, for example, were estimated as follows:

	Population in thousands		*Death rate per 1,000*		*Number of deaths*
Western Africa	94,383	×	28	=	2,642,724
Africa (total)	296,259	×	23	=	6,965,453

In order to estimate the number and rate of total deaths and deaths according to cause, it was frequently necessary to make a calculation for a region or division based on very few countries reporting within that area.

To begin with it was necessary to correct the data to produce a figure that indicated deaths from assignable cause. Accordingly, the entries under B45—"Senility without mention of psychosis, ill-defined and unknown causes"—were subtracted from the total recorded deaths and this adjusted figure was used as the "total" figure in the calculations for deaths by cause. A ratio was then computed for each region of the total estimated deaths to the total number of deaths from assignable cause within that region. For example, Western Africa had a total of 6,733 deaths from the two countries reporting, and a total of 780 deaths from ill-defined causes (B45), leaving 5,953 deaths from assignable cause. In that region there were an estimated 2,642,724 deaths, giving a ratio of 443·93 : 1. This figure was used throughout the calculations of death by cause for that particular region to estimate the number of deaths from a specific disease. As an example, from the 166 cases of death from tuberculosis reported in the two countries providing statistics in Western Africa an estimate was made of $166 \times 443 \cdot 93 = 73,692$ deaths from tuberculosis in that region. The ratio used as an illustration is a particularly high one, because of the scarcity of countries reporting, whereas in regions like Japan, Australia and New Zealand, North America, Western and Northern Europe, it is practically 1 : 1.

The death rate for a particular disease was calculated from the estimated number of deaths, as computed above, as a proportion of the population for the region or the major division, and expressed as deaths per 100,000 population. In Western Africa the death rate from tuberculosis was determined as

$$\frac{73,692}{94,383,000} \times 100,000 = 78 \text{ per } 100,000.$$

The results of these calculations are shown in Table V. These figures should be considered against the background of deaths from all causes. Our estimates of deaths in the world in 1963, from all causes, is 52,500,798 in a population of 3,165,078,000, producing a rate of 16·6 per 1,000. Deaths from infectious diseases total 17,214,046, a rate of 5·4 per 1,000. Deaths from infectious diseases therefore amount to 32·6 per cent of deaths from all causes.

Among the communicable diseases, pneumonia heads the list, followed by tuberculosis. Obviously there is considerable overlap between these two categories, depending on the degree of medical sophistication of the countries concerned. In some countries of the world there would be overlap between pulmonary tuberculosis and many of the other upper respiratory diseases. In the diarrhoeal diseases, probably with the exception of