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From Basic Data to Composite Indices: a Re-examination of Mortality Analysis

The importance of mortality data was recognized long before a much broader concept of public health had been developed. The first example of systematic death counts dates back to the black plague in England in the 1500s and by the mid-1600s, John Graunt had instituted a systematic collection of the numbers and causes of death and applied the first life-table methodology to these data.[1] For most of the following centuries, the characterization of the health of populations was based on mortality and survival. Although the description of health has evolved in time to include additional dimensions, deaths remain among the most important public health events to be measured and analyzed.

The main source of data on deaths is civil registration. Although in most countries of the world there exist institutional, legal and technical settings to perform the recording of vital events, underregistration and the variable quality of the information on these events are pervasive. In the Region of the Americas, underregistration was estimated to vary between 0.5% in the United States to 92.1% in Haiti around 1997.[2] The percentage of ill-defined causes of death, an indicator of the quality of mortality data, also varied from 0.5% in Cuba to 44.7% in Haiti.[2] Other sources of mortality data available for use, depending on the characteristics of the country, include health services, cemeteries, and even police records and the press.

Mortality data are the basis for a wide range of indicators of varying complexity. They not only represent tools to assess the risk of dying in a population and the impact of diseases on health, but also the severity of diseases and survival experienced by the population. As such, they are an essential element in health situation analysis, public health surveillance, program and policy planning and evaluation.

Because of the importance in public health to understand and utilize mortality indicators, over the last 23 years, articles have been regularly published in the *Epidemiological Bulletin* on characteristics of mortality data, techniques and tools used for mortality analysis, and changes in the countries' mortality profiles in the Region. There is now renewed interest in this topic, particularly in the context of monitoring the United Nations' Millennium Development Goals.[3]

Over the next few issues, the *Epidemiological Bulletin* will revisit this topic in a systematic way and provide articles on both the traditional measures of death as well as the latest developments in this field. These articles will be designed, not only to enlighten the technical and practical aspects of mortality measures, but also to prepare readers for the application to public health challenges, hopefully promoting two essential public health functions — health situation analysis and surveillance in public health. Following are the seven general topics that will be addressed in future issues of the *Epidemiological Bulletin*.

(1) International Classification of Diseases

There exist important issues regarding the level and quality of the registration of deaths that impact on the usefulness of mortality statistics. To address them, themes related to the International Classification of Diseases, such as the registra-

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tion of vital events and methods to adjust for under-registration, death certification and coding, and tabulation of mortality data will be presented. This issue of the *Epidemiological Bulletin* includes a first article in the series that deals with the creation of short lists for the tabulation of mortality and morbidity data.

(2) Mortality rates, ratios and proportions

One of the main uses of mortality rates is to indicate the overall and absolute magnitude of mortality in a population. General mortality rates present an array of options for comparative analysis. These options include *population-specific* rates such as sex- or age-specific, maternal or infant mortality rates, and *cause-specific* mortality rates. Mortality data may also be used to measure the severity of diseases and the impact on the population of specific causes of death. In summary, they give substance to the mortality profile of a population. Detailed presentation of mortality rates, proportional mortality, and case-fatality rates will be included in the series of articles.

(3) Survival and life expectancy

Studying mortality implies not only looking at what causes people to die, but also when and where they die. One of the major objectives of public health is to postpone preventable death, reducing the burden of avoidable and premature mortality. Mortality data are used to analyze the survival of a population and to calculate life tables that allow estimation of the life expectancy of individuals and population groups. Survival analysis and life tables provide a probabilistic picture of time to death that can be used to compare populations with different exposures to mortality risk factors. The concept of survival is also used in longitudinal epidemiological studies and clinical trials, as a way to express prognosis. Another use of premature and avoidable mortality indicators is to evaluate and improve health services.

(4) Period, cohort and age effects

The study of mortality patterns includes examining the evolution of indicators over time. This requires an understanding of the impact that risk factors associated with different variables may have on mortality. A future article will address the impact of events or processes that occur during particular dates or calendar periods, called the *period effect*; that of characteristics of a birth cohort over time, called the *cohort effect*; and the impact of aging of a population on mortality, called the *age effect*.

(5) Years of Potential Life Lost

Years of Potential Life Lost (YPLL) is another measure derived from mortality data. It provides an estimate of the years lost due to premature death based on a predetermined life expectancy. Deaths at a younger age have a greater impact on this measure because more potential years of life are lost. As opposed to age-specific or cause-specific mortality, this provides a measure of "prematurity" of death.

(6) Impact of diseases on the change in life expectancy and Years of Life Expectancy Lost

Based on a methodology developed by Arriaga using life expectancy at birth and mortality data, it is also possible to measure the contribution of each cause of death to the changes in life expectancy.[4] This recent innovation in mortality analysis will be presented, along with the concept of Years of Life Expectancy Lost (YLEL). YLEL, a different indicator than YPLL, uses life expectancy to calculate the years lost in a population due to the mortality experienced for such population.

(7) Disease-Adjusted Life Years (DALYs), Quality-Adjusted Life Years (QALYs)

The number of deaths alone can constitute indicators or they can be used in conjunction with other health measures to construct new health indices. For example, they may be combined with variables indicating the impact of premature death and disability into disability-adjusted life years[5] (DALYs) or with quality of life into quality-adjusted life years (QALYs).

The analysis of mortality data does not give a complete picture of the health situation but it provides essential information about the health of a population. Mortality measures have evolved and become more complex and encompass different dimensions of health. In its most simple or most complex forms, they remain important tools for situation analysis and decision-making in public health.

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International Classification of Diseases: Preparation of Short Lists for Data Tabulation

Introduction

The International Classification of Diseases (ICD) has expanded notably with each successive revision. Improvements included more detailed information in many categories, and the creation of new categories as knowledge of diseases advanced and new ones were discovered. One of the most important changes occurred between the Fifth and Sixth Revisions, when the ICD changed from a "classification of causes of deaths," with some 200 categories, to a "classification of diseases and causes of deaths," with more than a thousand categories. Thus, from Bertillon's original 1893 Classification (the "ICD-Zero") with a total of 161 categories and 200 codes, there is now the ICD-10[1], implemented worldwide since 1994, which currently contains a total of 12,421 codes distributed in 2,036 categories.

The greatest degree of detail allows for more in-depth analyses by diseases, either individually or in specific groups. However, it hinders the complete tabulation of data to obtain a panoramic view of the health situation, identify the most relevant problems and define priorities. For this reason, the ICD itself offers shorter lists, based on the aggregation of several categories into a single group. Bertillon's classification, for example, was presented in three "nomenclatures:" a short one comprised of 44 categories, an intermediate of 99 categories, and a most detailed of 161. The ICD-10 contains 21 Chapters, which are broken down into 261 groups containing a total of 2,036 categories. It also offers four special (short or condensed) lists for tabulating mortality data and one for morbidity.

Basic principles

Despite the availability of many short lists, it may be necessary to construct lists that are more specific to the situation to be analyzed. Ideally, the process to create these lists should involve using an available list closest to the needs, testing it with real data, and then making the necessary adjustments. It is important to remember that the comparisons between regions or countries are possible only if the same list has been used for all the areas under study. As mentioned below, PAHO currently offers and develops short lists for specific uses.

For both mortality and morbidity, the process to group diseases — that is the **list** to be selected — will depend essentially on the type of analysis intended.

Basic principles for the construction of short lists for mortality and morbidity data tabulation include:

- The organization of the list should be based on the ICD codes; the categories of the list should be mutually exclusive.
- The categories should be as informative as possible, avoiding residuals usually identified by the expressions "other", "the remainder" or "not specified." However, in order to guarantee the inclusion of all cases, at least one residual category ("all the others") is necessary.
- In mortality data tabulation, the "ill-defined" causes (symptoms, signs and abnormal clinical and laboratory findings, Chapter XVIII of the ICD-10) should be shown separately, not as a category of the list. In morbidity analyses, it may be necessary to present symptoms and signs as one or more categories of the list.
- It is not necessary to organize the categories of the list as in the chapters of the ICD. Indeed, in order to do this, several residual categories would be needed to complete the chapters, thereby increasing the proportion of cases in little-informative categories.
- The categories of the list can correspond to single codes of the ICD (three-character categories, but not four-character subcategories), and codes of different chapters or entire chapters of the ICD, in accordance with the needs.
- The preparation of a list should be based on the current Revision of the ICD (ICD-10). The rationale is that the list should be oriented to current situations and used for many years. The preparation of an equivalent list for the ICD-9 or previous revisions should be, accordingly, a secondary objective.
- The number of categories in a short list should be sufficiently broad to meet the requirements above, but not excessive to the point of hindering its complete presentation. The majority of the short lists used in mortality and morbidity have between 30 and 150 categories.
- The morbidity short lists should usually be different from the ones used for mortality. One reason is that many codes in the ICD cannot be used as an underlying cause of death but can be used in morbidity.

Short lists for Mortality

If the objective is, for example, to obtain a panoramic view of the causes of death of a country or region as a starting point for an analysis, a short list such as the PAHO-6/67 list may be used. The 6/67 list has six broad groups of causes that are divided into 67 detailed groups (see Table 1).[2]

For a more in-depth analysis, it is usually necessary to use a more specific list. For an analysis of mortality patterns in specific population groups, the lists should focus on the most common health problems in this group. If the objective is, for example, to analyze infant mortality, the list should detail the most common causes of death during the first year of life, such as infectious and parasitic diseases, malnutrition, congenital malformations and conditions originating in the perinatal period.

For the study of mortality in school-age children or adolescents, it is important that the list used emphasize external causes, among others, since they usually represent the majority of deaths. In studying mortality trends in adults, AIDS, diabetes, neoplasms and diseases of the circulatory system are worth pointing out, in addition to external causes. In the more advanced ages, chronic degenerative processes, including neoplasms and cardiovascular, endocrine and metabolic diseases, should be included.

Another important *axis* for grouping causes of death is using preventability criteria, developed by Taucher and oriented toward the definition of priorities and the evaluation of health measures and programs.[3] This type of list, which can also be used for morbidity, has a structure similar to that of PAHO's 6/67 list, meaning that the large groups would include diseases preventable with the same type of measures. For example:

- Deaths avoidable by vaccination (e.g. measles or tetanus)
- Deaths avoidable by early diagnosis and timely and adequate treatment (e.g. tuberculosis, syphilis or causes of maternal mortality)
- Deaths avoidable by application of hygienic measures, environmental sanitation, and health education (e.g. intestinal infectious diseases, intoxication due to air pollution)
- Deaths avoidable by application of a combination of measures (measures included in more than one group)
- Deaths difficult to avoid with current knowledge and technological development
- Remaining deaths (causes not identified in any of the previous groups)

The preventability criteria of causes of death can vary depending on the historic moment, the availability of technologies or resources, the experience of a given country or region, or also when comparing with specific paradigms. An interesting discussion on this topic appeared in the article "Avoidable Mortality: Indicator or Target? Application in Developing Countries" published in the *Epidemiological Bulletin* in 1990.[4]

One frequently used way to tabulate causes of death is ranking the *leading causes*, in order to identify priority problems and define policies and health programs. In addition to the aforementioned basic principles, it is recommended that a short list for that purpose have the following characteristics:

- The axis for grouping causes should have an epidemiological basis, associated with the idea of control measures.
- Residual categories should be avoided, preferably using only one for "all remaining causes." Ideally, that residual category should not contain more than 10% of the total. Furthermore, that category and the "ill-defined" categories should not be included among the principal causes, but presented separately.
- A balance should be sought between grouping and disaggregation, so that the five leading causes of death in the general population may represent some 40-50% of the deaths and the ten or fifteen first causes, around two thirds. Overloaded and frequently heterogeneous categories, such as "heart diseases" or "malignant neoplasms", should be avoided. Since the purpose is to show the leading causes, diseases of low frequency such as "rare events", for example rabies, poliomyelitis or yellow fever, should also be avoided.
- In order to facilitate the tabulation and analysis, the list should have a single hierarchical level. The breakdown of the categories for more elaborate analyses can be done with other types of tabulations.
- The list should be based on the ICD-10 and on the current situation, since it is used to support current analyses, definition of priorities, health programs and policies. Several short lists are included in Volume 1 of the ICD-10. The study of trends or the comparison with past situations may require another type of tabulation.
- A preliminary version of the list should be tested with the most recent real mortality data. The ideal is to tabulate data of areas with different levels of health and/or age distribution, which makes it possible to test the capacity for information and the discriminating power of the list. Furthermore, the ordering of the data with different types of indicators can also facilitate the evaluation of the list, for example ordering by frequency of deaths and also by Years of Potential Life Lost (YPLL).[5]

A list that meets such criteria will probably have a total of between 40 and 80 categories. PAHO has prepared a specific list for ordering leading causes of death. It is currently under revision and is being tested with data from different countries. Once this process is completed, the list will be disseminated and its use recommended.

Short lists for morbidity

As mentioned before, there usually is a need for specific lists for morbidity. That is due mainly to the fact that the probability of death varies widely depending on the type of disease. Some diseases present a high incidence but rarely cause death. An example of difference between mortality and morbidity lists is that of normal delivery. Indeed normal deliveries, which cannot be a cause of mortality, appear in the lists of principal diagnosis for hospital discharge, which are often used as morbidity lists.

As discussed above, the type of short list to be used is determined by the type of analysis to be done. Lists for morbidity require the definition of an additional element: the type of data to be used (hospital discharges, outpatient consultation, primary care or others). For outpatient consultations and primary care, the data are not always coded, and when they are, the ICD is not always directly used. Various countries have developed their own lists for outpatient consultations, usually derived from the ICD or primary care classifications, but adapted to their specific needs. Furthermore, the possibility of obtaining clear and defined diagnoses is smaller than in cases of hospitalization. For that reason, the preparation of short lists for hospital discharges only is discussed below.

Contrasting with what occurs with mortality, the use of morbidity data follows different criteria and purposes in different countries and even within countries. The most frequent use of morbidity data is for payment of medical care, especially hospital care, which represents a distortion of the use of data, in view of the fact that the cost is related to the procedure and not to the diagnosis of the disease.

The creation of *Diagnosis-Related Groups* (DRG)[6] was one of the solutions for that problem, which at the same time provides a short list for tabulation. This system classifies patients in groups that have similar characteristics, related to the procedures and interventions they need as well as age group and occurrence of complications. The system was orig-

Table 1: PAHO 6/67 List for tabulation of mortality data (ICD-10)

0.00 Symptoms, signs and ill-defined conditions (R00-R99)
1.00 Communicable diseases (A00-B99, G00-G03, J00-J22)
1.01 Intestinal infectious diseases (A00-A09)
1.02 Tuberculosis (A15-A19)
1.03 Certain vector-borne diseases and rabies (A20, A44, A75-A79, A82-A84, A85.2, A90-A98, B50-57)
1.04 Certain diseases preventable by immunization (A33-A37, A80, B05, B06, B16, B17.0, B18.0-B18.1, B26)
1.05 Meningitis (A39, A87, G00-G03)
1.06 Septicemia, except neonatal (A40-A41)
1.07 HIV disease (AIDS) (B20-B24)
1.08 Acute respiratory infections (J00-J22)
1.09 Other infectious and parasitic diseases (remainder of A00-B99, i.e. A21-A32, A38, A42-A43, A46-A74, A81, A85.0-A85.1,A85.8, A86, A88-A89, A99-B04, B07-B15, B17.1-B17.8, B18.2-B19.9, B25, B27-B49, B58-B99)
2.00 Neoplasms (C00-D48)
2.01 Malignant neoplasm of stomach (C16)
2.02 Malignant neoplasm of colon and rectosigmoid junction (C18-C19)
2.03 Malignant neoplasm of digestive organs and peritoneum, except stomach and colon (C15, C17, C20-C26, C48)
2.04 Malignant neoplasm of trachea, bronchus and lung (C33-C34)
2.05 Malignant neoplasm of respiratory and intrathoracic organs, except trachea, bronchus and lung (C30-C32, C37-C39)
2.06 Malignant neoplasm of female breast (C50 in women)
2.07 Malignant neoplasm of cervix uteri (C53)
2.08 Malignant neoplasm of corpus uteri(C54)
2.09 Malignant neoplasm of uterus, part unspecified (C55)
2.10 Malignant neoplasm of prostate (C61)
2.11 Malignant neoplasm of other genitourinary organs (C51-C52, C56-C57, C60, C62-C68)
2.12 Leukemia (C91-C95)
2.13 Malignant neoplasm of lymphoid, other hematopoietic and related tissue (C81-C90, C96)
2.14 Malignant neoplasm of other and unspecified sites (remainder of C00-C97, i.e. C00-C14, C40-C47, C49, C50 in men, C58, C69-C80, C97)
2.15 Carcinoma in situ, benign neoplasms and neoplasms of uncertain or unknown behavior (D00-D48)
3.00 Diseases of the circulatory system (I00-I99)
3.01 Acute rheumatic fever and chronic rheumatic heart diseases (I00-I09)
3.02 Hypertensive diseases (I10-I15)
3.03 Ischemic heart diseases (I20-I25)
3.04 Pulmonary heart disease, diseases of pulmonary circulation and other forms of heart disease (I26-I45, I47-I49, I51)
3.05 Cardiac arrest (I46)
3.06 Heart failure (I50)
3.07 Cerebrovascular diseases (I60-I69)
3.08 Atherosclerosis (I70)
3.09 All other diseases of the circulatory system (I71-I99)
4.00 Certain conditions originating in the perinatal period (P00- P96)
4.01 Fetus and newborn affected by certain maternal conditions (P00, P04)
4.02 Fetus and newborn affected by obstetric complications, birth trauma (P01-P03, P10-P15)
4.03 Slow fetal growth, fetal malnutrition, short gestation, low birth weight (P05, P07)
4.04 Respiratory disorders specific to the perinatal period (P20-P28)
4.05 Bacterial sepsis of newborn (P36)
4.06 Remainder of certain conditions originating in the perinatal period (rest of P00-P96, i.e. P08, P29, P35, P37-P96)
5.00 External causes (V01-Y89)
5.01 Land transport accidents (V01-V89)
5.02 Other and unspecified transport accidents (V90-V99)
5.03 Falls (W00-W19)
5.04 Accidents caused by firearm discharge (W32-W34)
5.05 Accidental drowning and submersion (W65-W74)
5.06 Accidental threats to breathing (W75-W84)
5.07 Exposure to electric current (W85-W87)
5.08 Exposure to smoke, fire and flames (X00-X09)
5.09 Accidental poisoning by and exposure to noxious substances (X40-X49)
5.10 All other accidents (W20-W31, W35-W64, W88-W99, X10-X39, X50-X59, Y40-Y84)
5.11 Intentional self-harm (suicide) (X60-X84)
5.12 Assault (homicide) (X85-Y09)
5.13 Event of undetermined intent (Y10-Y34)
5.14 All other external causes (Y35-Y36, Y85-Y89)
6.00 All other diseases (D50-D89, E00-E90, F00-F99, G04-G98, H00-H59, H60-H95, J30-J98, K00-K93, L00-L99, M00-M99, N00-N99, O00-O99, Q00-Q99)
6.01 Diabetes mellitus (E10-E14)
6.02 Nutritional deficiencies and nutritional anemia (E40-E64, D50-D53)
6.03 Mental and behavioral disorders (F00-F99)
6.04 Diseases of the nervous system, except meningitis (G04-G99)
6.05 Chronic lower respiratory diseases (J40-J47)
6.06 Remainder of diseases of the respiratory system (rest of J00-J99, i.e. J30-J39, J60-J98)
6.07 Appendicitis, hernia of abdominal cavity and intestinal obstruction (K35-K46, K56)
6.08 Cirrhosis and certain other chronic diseases of liver (K70, K73, K74, K76)
6.09 All other diseases of the digestive system (rest of K00-K93, i.e. K00-K31, K50-K55, K57-K66, K71, K72, K75, K80-K93)
6.10 Diseases of the urinary system (N00-N39)
6.11 Hyperplasia of prostate (N40)
6.12 Pregnancy, childbirth and the puerperium (O00-O99)
6.13 Congenital malformations, deformations and chromosomal abnormalities (Q00-Q99)
6.14 Remainder of all other diseases (rest of A00-Q99, i.e. D55-D89, E00-E07, E15-E34, E65-E90, H00-H59, H60-H95, L00-L99, M00-M99, N41-N99)

inally designed in order to improve the internal administration of the hospitals. Later, it became a mechanism for payment of care. As a result of the reduction in hospital costs generated by the use of the DRG in the United States, other countries are now using them or planning to use them. However, the use of DRG requires specific studies in each country, in order to make the necessary adjustments using the countries' own criteria in accordance with local and national characteristics. The construction of DRG requires a relatively large quantity of good quality data and the availability of experts in classification, statistics, and computation. In the United States for example, the list that was used originally presented 470 DRG. Examples of DRG include "vaginal delivery without complicating diagnoses", "Esophagitis, gastroenteritis, and miscellaneous digestive disease age 70 and over and/or substantial comorbidity and/or complication", "Circulatory disorders with acute myocardial infarction without cardiovascular complications, discharged alive", "Bronchitis and asthma age 18-69 without substantial comorbidity and/or complication", or "Medical back problems".

Even if the coding of causes of death is made in the same way throughout the world, using rules of selection for the underlying cause, the same does not hold true for the selection of a corresponding unique diagnosis for an episode of hospitalization or outpatient consultation. Even though there exist rules defined for selecting a unique diagnosis for an episode of hospitalization since the ICD-9, the majority of countries that code hospital morbidity have made modifications and adaptations to the rules, in accordance with their interests and needs.

The concept of underlying cause of death is clear and known: it is "the disease or injury which initiated the chain of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury."[1] The same does not occur with the concept of "main condition" of a hospital discharge. The definition from the ICD-10 is: "the condition diagnosed at the end of the episode of health care, primarily responsible for the patient's need for treatment or investigation. If there is more than one such condition, the one held responsible for the greatest use of resources should be selected."[1]

As can be noted, the definition is neither completely clear, nor will it yield the most useful selected diagnosis, in particular for health situation analysis, as for example in the case of mortality data. There are at least three different ways to select a unique diagnosis for hospital discharge, each related to a different type of analysis:

- *Reason for hospitalization*: the disorder established, after study, as primarily responsible for admission of the patient to the hospital
- *Main condition*: the disorder treated during the hospitalization, considered as the most important in terms of clinical significance and resources used
- *Underlying cause of hospitalization*: the underlying cause of the disorder that caused the hospitalization of the patient.

The *reason for hospitalization* is related to the need for immediate care of the patient and to the availability of human and technological resources, while the *main condition* is strongly related to costs, procedures and financing of the health system. In addition, the *underlying cause* is much more related to health situation analysis, the main health problems, prevention measures, health policies and programs.

The three types of unique diagnosis can lead to the same disease or disorder, or to more than one problem, disorder, condition, disease, or pathology, depending on each situation. Two examples are presented below:

1. A patient is discharged from the hospital, having been treated for an uncomplicated acute appendicitis. The selected diagnosis will be the same with any of the aforementioned criteria.
2. A patient of 70 years of age is admitted for a rhinoplasty in order to correct sequelae of lacerations which occurred in a car accident two years earlier. Before being discharged, the patient falls from the bed, fracturing her femur. After 6 days of treatment of the fracture, she suffers an embolism and dies 12 hours later. In that case, the unique diagnosis differs depending on the criterion used. The *main condition* to be selected could be the fracture of the femur complicated by an embolism. The *reason for hospitalization* was a sequelae of an injury to the nose and the *underlying cause of hospitalization* was a transport accident. Finally, a fourth unique diagnosis could be selected for the underlying cause of the death: fall from bed (external cause).

As can be noted, the type of short list to be used requires that the type of analysis be defined but also, in the case of morbidity, that the criteria for coding be clearly defined. Once defined, the preparation of a short list for hospital discharges should follow the same general principles as those discussed for the preparation of mortality lists. However, if the type of analysis to be carried out is not a "health situation analysis", as is done in mortality, at least two important differences should be considered:

- If the *underlying cause of hospitalization* is not used, codes corresponding to the *nature of the injuries* for the selected unique condition should be used, and not those of the *external cause of the injuries*.
- ("Ill-defined") signs and symptoms can be part of the list and tabulated together with the other categories.

Conclusions

The results and conclusions of health analyses using mortality or morbidity data can be influenced in many different ways. Some factors that come into play are related to coverage and quality of the data including, among others, the precision and adequacy of medical information on diagnoses, types of variables used, coding, consistency and adequacy of the data, and the correct use of statistical standards, for example the definitions of live birth and stillbirth.

However, one of the factors that has the most impact in the analyses is the way data is organized and tabulated, depending on the type of data (mortality or morbidity) and the type of analysis required. As a result, the choice of an adequate list (or the construction of a specific one) is fundamental for organizing the data. It allows for relevant health problems to appear in their adequate dimension, avoiding erroneous or biased conclusions that may damage evaluations and decisions and hinder the comparability between areas or time periods.

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Source: Prepared by Dr. Roberto Becker of PAHO's Special Program for Health Analysis (SHA).

Development of the Healthy Condition Index Using Geographic Information Systems in Health

One of the imperatives in health is the reduction of inequities between population groups or geographical areas within a country or region.[1] The identification of those population groups that present greater unmet health needs is an essential public health function and its systematic fulfillment will make it possible to monitor the health situation and orient policies and health programs aimed at eliminating or reducing such inequalities in health.

Health needs in a geographical area or population group are usually characterized by variables and indicators that represent different dimensions. Unmet health needs are not only expressed through morbidity and mortality indicators; because they are related to health determinants, socioeconomic indicators and indicators of resources, access, and health services coverage are also an important source of information for the evaluation of such needs (social indicators approach).[2,3] In this regard, the need is expressed as an injury or risk for health, or as a deficiency. In contrast, when looking at health in terms of quality of life,[4] where more weight is given to the determinants than to the consequences of the disease, a healthy situation will arise where better living conditions, availability of resources and greater well-being exist.

In order to facilitate the allocation of resources, it is sometimes necessary to synthesize the information into a single index. That index should take into account the different aspects of the health situation, be simple to calculate and consider the distribution of all groups, including geographical patterns. Following these requirements, this article presents a procedure to calculate a simple healthy conditions index that may be used to guide decision-making in health, including the use of a geographic information system developed at PAHO.

Materials and methods

National-level health indicators from PAHO's Core Health Data System were used for these analyses.[5] For examples at the subnational level presented here, data from the first subnational level (e.g. states, provinces or departments) were used, as published, following the recommendations on standards, by the countries in their Basic Indicators brochures and mentioned in PAHO's Annual Report of the Director for 2000.[6]

The cartographic databases of the national and first subnational level used to display thematic maps of the Americas come from the Digital Atlas of the World[7] and were edited by PAHO;[1] these maps are presented at a scale of 1:100,000,000. The georeferenced data were processed and analyzed with the computer package SIG-Epi.[8] Thematic maps using choropleth ranges were prepared to describe the geographical distribution of the variables, including quantiles as a method of classification of groups (quintiles). Different data layers were superposed to show their spatial distribution and relation. SIG-Epi's Composite Health Index calculation tool was used for processing the georeferenced data. The results were grouped in accordance with an ordinal scale showing favorable, average and poor health conditions.

The selection of indicators for the healthy conditions index was based on the following criteria: 1) availability for all the countries of the Region of the Americas; 2) representativeness of various dimensions of health; 3) accepted validity; 4) generated by routine information systems; and 5) with sufficient variability to discriminate between situations. Following these criteria, indicators were included that reflect a healthy environment and infrastructure (population coverage of water and of sanitary disposal of excreta), community development (percentage of urban population), availability of health resources (physicians per population), and access to health services (coverage of vaccination in infant population). Other indicators of human capital development (literacy) and well-being (life expectancy at birth) were included to complement the index. Some of the indicators included in the index were not available at the subnational level; consequently, alternative indicators representing the appropriate dimensions of each area of analysis were used to exemplify the procedure, including population growth rate, total fertility rate, frequency of low birthweight and infant mortality as "proxy" indicators for community development, access to health services and for well-being, respectively.

Once the indicators are identified, it is necessary to define how to combine indicators with different units of measure to calculate a unique standard index. Different procedures can be applied, but a simple and statistically robust one consists of standardizing all the units into a single scale. To this end, *Z-scores*[2] were calculated. Z-scores represent one of the most commonly applied methods used in measuring and characterizing individuals with regard to their populations. They measure the distance between the value of an observed unit and the distribution average, which would represent an expected achievable level.[9] This approach is best known for its use in the evaluation of the nutritional status of preschool children.[10]

The average and the standard deviation of a frequency distribution of the population are required to obtain the Z-scores. In the present study, the Z-score of each geographical unit for each indicator was calculated as the difference between the observed and mean values, divided by the standard deviation, as follows: $Z = \frac{(X_i - \overline{X})}{S}$ where Xi is the observed value, $\overline{X}$ the average and S the standard deviation. The healthy condition index (HCI) for each geographical unit was obtained by calculating the algebraic sum of the Z-scores for each indicator, as follows:

$$HCI = Z_1 + Z_2 + Z_3 + \ldots + Z_n \,.$$

Finally, the results of the sums were ordered and re-classified in quantiles in order to identify the geographical or population groups with the highest total scores, that is, those with the best health conditions. The results of the indices were presented in thematic maps.

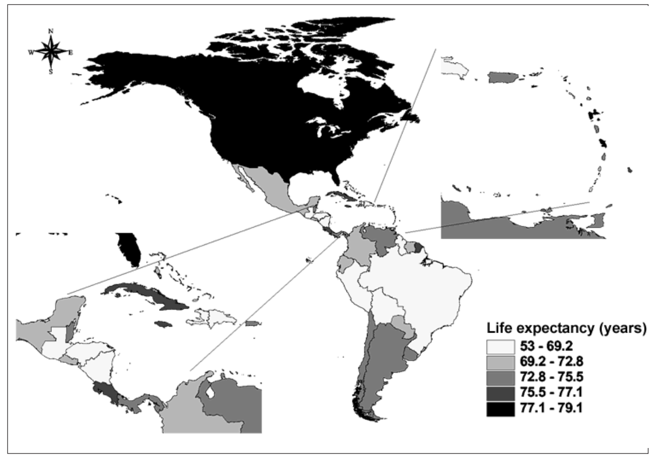
Results

Thirty-nine of the 48 countries and territories of the Region were included in the analysis, corresponding to those with complete information on basic indicators for the period 1995-2000. The majority of unavailable data came from countries and small territories of the Caribbean.

As shown in Table 1, there exist large differences in the distribution of the values of the indicators composing the Healthy Condition Index (HCI) in countries of the Region. For example, the weighted average of the number of available physicians per 10,000 population in the Americas was 19.8; however, the ratio between the maximum and minimum values was 32 times greater in the most favorable situation than in the least favorable. In contrast, the weighted average of measles vaccination coverage in children under 1 was 92.5%, and the same ratio 1.3 times greater in the most favorable situation than in the least favorable. Important differences were also detected in the indicators at the subregional level. The highest values, except for the availability of physicians by population, are consistently found in North America, while the lowest ones tend to occur in Central America.

In the maps showing the distribution of indicators, some countries of the subregions consistently present the most favorable conditions. For example, life expectancy at birth exceeds 75 years (higher two quintiles) in 19 of the 48 countries (Figure 1). This group includes the United States and Canada in North America, half of the countries of the Caribbean, while in Central America and the different subregions of South America, only Costa Rica and Chile, respectively, have reached that level. The countries furthest from this level, which still do not reach 66 years of age, are Haiti, Guyana, Bolivia, Grenada, Honduras, and Guatemala. With regard to literacy, the percentage of literate population exceeds 95.5% in 20 countries in the Americas (Figure 2). The greatest percentages are found in Canada and the United States in North America, Costa Rica in Central America, Argentina, Chile, and

Figure 1: Life expectancy at birth (in years) in the Americas, 2001



Uruguay in the Southern Cone, Guyana, Cuba, and other countries in the Caribbean. In that same subregion, the situation is more precarious in Haiti, while in Central America, El Salvador, Guatemala, Honduras, and Nicaragua present the smallest fraction of literate population with less than 75%. A similar distribution is seen for the coverage of drinking water. While 20 countries of the Region show levels higher than 93%, 7 have not exceeded 75% (Figure 3). The availability of physicians is higher than 14 per 10,000 population in 18 of the countries (Figure 4), while in 18 other countries the coverage does not reach 10 physicians per 10,000. Unlike other indicators, the least favorable situation is found in little-populated countries of the Caribbean, in addition to Belize, Guatemala, Honduras, and Nicaragua in Central America and Bolivia and Paraguay in South America.

The HCI synthesizes all the indicators for countries of the Region, their ranking and the distance with respect to the regional values (Figure 5). The most favorable conditions, with higher values of the HCI, are found in Canada, the United States and Mexico in North America; Costa Rica and Panama in Central America; Barbados, Cuba, French Guiana, Trinidad and Tobago in the Caribbean; Venezuela in the Andean Area; and Argentina, Chile and Uruguay in the Southern Cone. In contrast, the countries with lower values, suggesting more

Table 1: Values of the Health Indicators which compose the Healthy Conditions Index in Regions and Countries of the Americas

	Indicator						
Region	Urban population (%) 2000	Life expectancy at birth (years) 1995-2000	Literate population (%) 1998	Population with access to water (%) 1998	Population with access to sewerage (%) 1998	Physicians (per 10,000 pop.) 1999	Measles vaccine coverage (%) 2000
The Americas	76.0	72.2	92.0	90.4	87.1	19.8	92.8
(min, max)	(12.3; 100)	(53.0; 79.1)	(47.8; 99.5)	(43.6; 100)	(23.4; 100)	(1.81; 58.2)	(75.0; 100)
North America	77.2	76.7	99.5	100.0	100.0	27.4	91.5
Mexico	74.4	72.2	90.8	86.5	72.5	15.6	96.0
Central America	48.3	68.1	75.3	77.1	77.8	10.2	93.2
Latin Caribbean	63.4	66.6	80.4	80.8	76.9	28.5	88.9
Brazil	81.3	67.2	84.5	89.0	84.8	14.0	99.0
Andean Area	75.0	69.7	90.4	81.8	73.5	11.7	85.3
Southern Cone	85.3	73.4	96.1	80.4	85.4	22.0	92.5
Non-latin Caribbean	58.9	71.5	91.1	87.4	90.1	7.2	88.8

Figure 2: Literate population (%) in the Americas, 2001

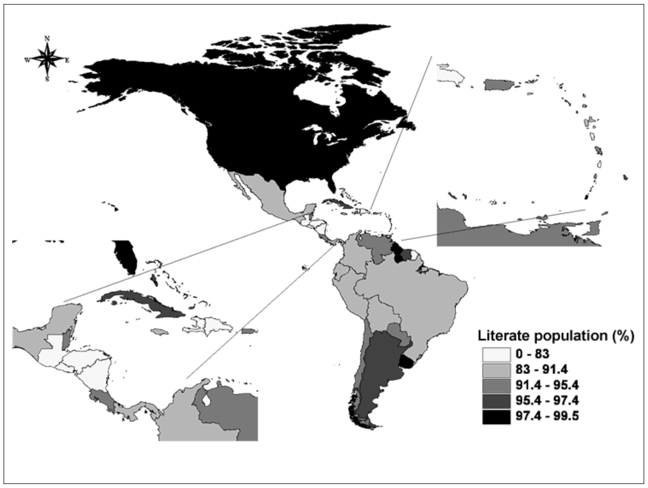


Figure 3: Population with potable water (%) in the Americas, 2001

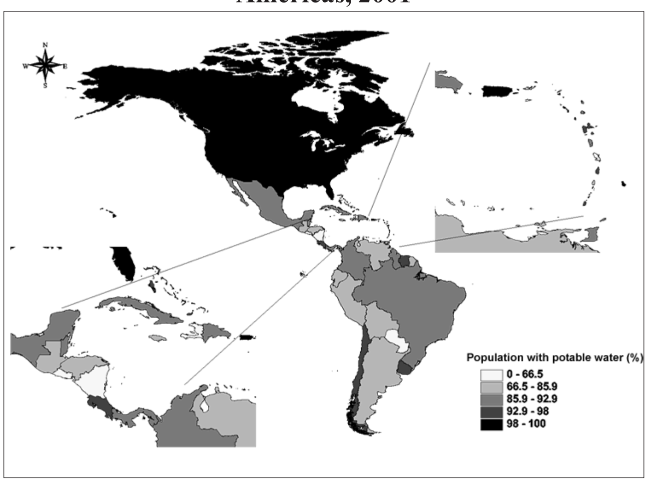


Figure 4: Physicians (per 10,000 pop.) in the Americas, 2001

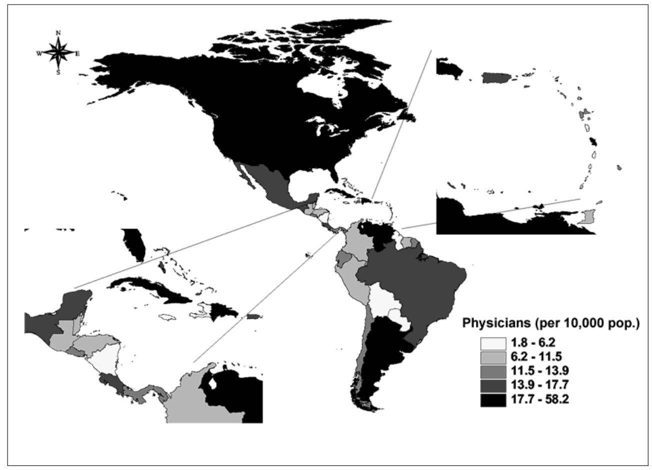
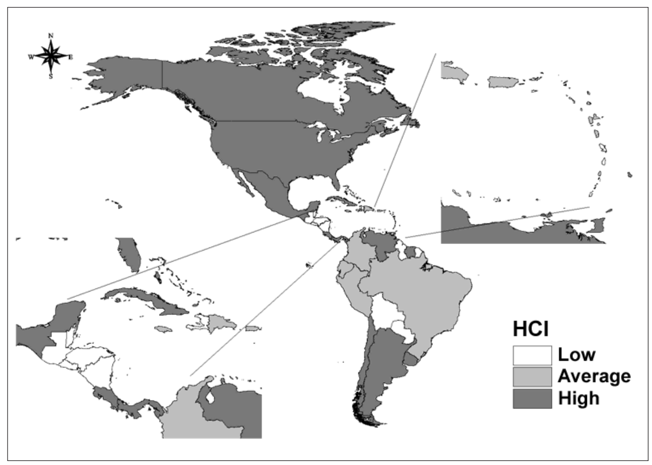


Figure 5: Healthy Conditions Index in the Americas, 2001



important needs, include Haiti, Guyana and Suriname in the Caribbean; Guatemala, Honduras, El Salvador, Nicaragua in Central America; and Bolivia and Paraguay in South America.

Within countries, the determination of healthy conditions follows the same heterogeneous mosaic pattern observed in the countries of the Region. The situation of Mexico is presented here to illustrate this aspect (Figure 6). Although some states in the south of the country generally show the lowest levels of all the indicators presented, this low level of the HCI is also found in other geographical units in the center of the country, potentially indicating low levels of some indicators and a more important deviation of the Z-score with respect to the rest of the states.

Finally, although values were not available for all the indicators to calculate the subnational level HCI, a map was prepared showing healthy condition indices for the countries of the Region, calculated with alternative indicators. This allowed identification of areas with less favorable health conditions (Figure 7). In the Region, various areas present less favorable conditions, that form "foci" or clusters of geographical units. In these groups, the probability of having a low HCI increases when neighbors have similar values. This is an important aspect for the stratification of areas according to their determinant factors and for planning of activities, particularly because many of the less favorable areas are in the borders between countries. This trend towards aggregation is also observed for the most favorable health conditions, but is less frequent in the border areas. It is important to note that the observed differences are based on the calculation of the HCI at the country and not the regional level. This means that low values are not comparable in different countries; however it makes it possible to identify areas where the countries themselves should intervene.

Discussion and general comments

The characterization of healthy places and the monitoring of their conditions are considered essential elements to orient efforts to reduce inequalities in health through additional care and health promotion. The use of indices that summarize information on various dimensions of health development has been suggested in order to make the process of decision-making more efficient. Moreover, it has been recommended to include computerized technological tools, such as geographic information systems (GIS), that facilitate the management, visualization, query, and analysis of data. This

Figure 6: Distribution of the Healthy Conditions Index and some of its composant indices in Mexico, 2000

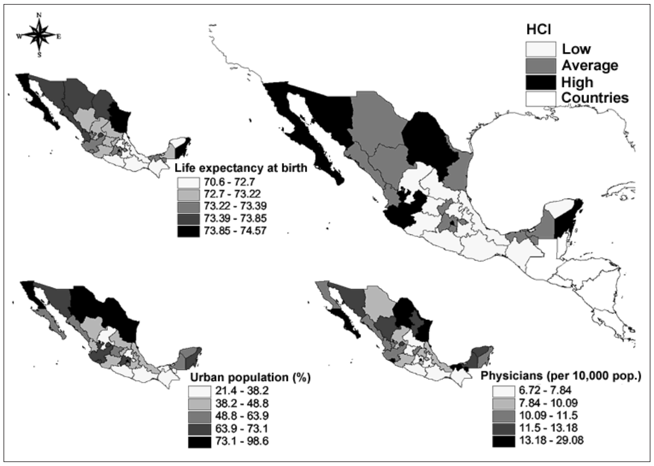
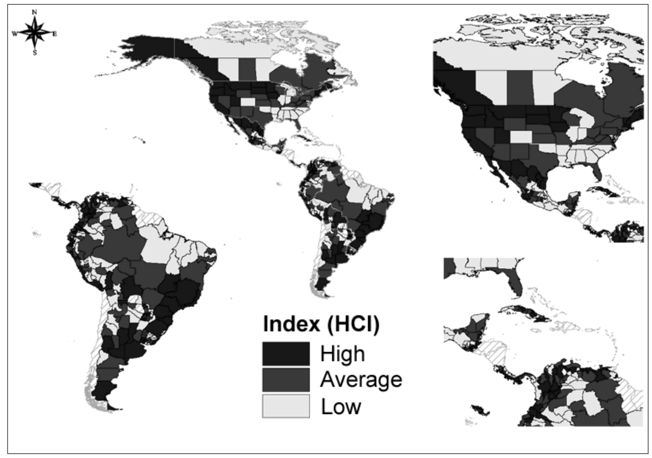


Figure 7: Healthy Conditions Index in Countries of the Americas, circa 2000 (Subnational level)



article presents the use of some positive indicators (i.e. not based on health impairments) and a procedure for standardizing the calculation of indicators, using the SIG-Epi system.

The results displayed in thematic maps showed that there exists a great variability in the distribution of the health conditions in the Region of the Americas at the country level and within the same. Greater consistency was also achieved in the identification of areas of more or less favorable health conditions through the use of the HCI, which would not have been achieved using a single indicator (see for example Figures 1, 4 and 5). Using the same group of indicators for the HCI, presented at the subnational level, illustrates that it is possible to identify with greater precision areas in which to target health efforts. The presence of contiguous unfavorable areas on the borders suggests the possibility of promoting efforts in such areas, using binational resources. This has been occurring in different subregional initiatives of health promotion, control and surveillance of health problems in the Southern Cone, the Andean Area, and Central America.

Specific numbers and types of basic health indicators routinely collected were used here, representing different dimensions of the health process. These indicators include important health determinants, and their specific analysis allows identification of areas of intersectoral work. The process of production and collection of basic data at the national level was initiated in at least 23 of the 48 countries and territories of the Americas, and efforts have been put in place to standardize their contents, as in the case of basic indicators of Central America (available as of 2003). At the subnational level, where the information did not exist, other alternative indicators were used, that represent the same dimensions of health. This implies that it is not indispensable (although recommendable) to dispose of the same basic indicators to calculate a healthy condition index. However, it is suggested to keep the set of indicators used in the calculation to the minimum necessary. It is also important to mention that in general, the use of different indicators provides results with a similar hierarchy, which indicates the consistency of the method. The selection of indicators for the Healthy Condition Index was based, among other reasons, on the availability of basic indicators for all the countries of the Region that represent various health dimensions, that were accepted for their validity, and generated by routine information systems. Before generating such an index and interpreting its results, it is recommended to carry out an exploratory analysis of the distributions of the indicators to be used and of its correlations, in order to select those that meet the minimum requirements mentioned previously.

There exist different procedures to assign scores, from the use of cut off points to methods based on regression. In 1996, PAHO utilized a procedure to identify healthy spaces.[11] The approach consisted of assigning a score of zero or one to the units of analysis in relation to the fulfillment of a criterion, which was to belong to the 3 superior quintiles of the frequency distribution of the indicator. This approach has the limitation that it does not account for the magnitude of the deviation of the group value with respect to the reference used, but only if this deviation exists or not. It can be mentioned that other more complex and precise statistical methods based on regression or principal component analysis also exist. However, both are computationally more complex and the former in particular requires the definition of weights for the variables. In contrast, the Z-score used in the present approach presents the advantage of utilizing the full distribution of values for the analysis and not only the extreme values or defined criteria. The Z-score also measures the relative distance between a unit of analysis and the average of the distribution, which would represent an achievable level in the absence of inequality. Other additional advantages of the procedure are the simplicity of its calculation and its additive and comparison properties.

Different computer packages may be used to carry out this analytical process. The epidemiological package for tabulated data EpiDat[12] makes it possible to calculate a composite health index. However, in order to incorporate the dimension of the spatial distribution of the indicators, the geographic information system SIGEpi[8] was used on this occasion, in particular the Composite Health Index calculation tool.

In short, from the perspective of health promotion, the detection and evaluation of healthy conditions is a critical step for the definition of priorities and intersectoral work in health, including the adjustment of health services. The use of the synthetic index proposed here, based on basic health indicators in the context of a GIS, facilitates the analytical process, allows for the identification of "foci" or population groups in less favorable conditions and, through this, orients the formulation of adequate health plans and programs. When the units of analysis are smaller, the results are more specific and useful for decision-making. For this reason, it is recommended to promote the collection and use of disaggregated information at the level of municipalities, taking into account the fact that in most countries, they correspond to the operational units for health services.

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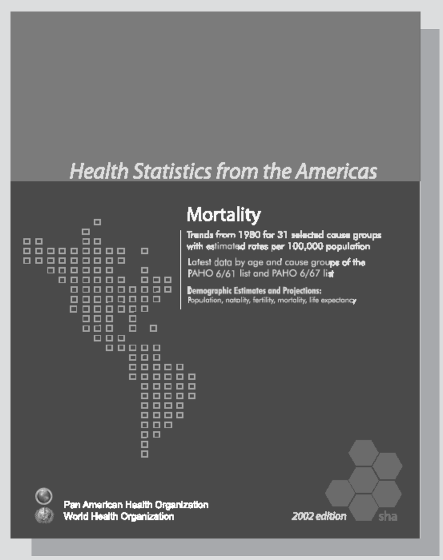
Source: Prepared by Drs. Carlos Castillo-Salgado and Enrique Loyola of PAHO's Special Program for Health Analysis (SHA), from a presentation at the Health Promotion Forum of the Americas organized by PAHO and the Ministry of Health of Chile, Santiago, Chile, 20-24 October 2002.

Soon Available Online: *Health Statistics from the Americas, 2003 Edition*

Health Statistics from the Americas, 2003 Edition is *soon* to be available in electronic format only on the PAHO web site (www.paho.org). The publication complements the quadrennial publication *Health in the Americas* and is the fifth in a series begun in 1991. This is the first edition to publish summarized mortality data by age group and sex for causes of death coded according to the Tenth Revision of the International Classification of Diseases (ICD-10).

The 2003 edition contains mortality data for 177 country-years from 35 countries received after publication of the 1998 Edition of this series. It includes 115 country-years of mortality data coded with the Ninth Revision (ICD-9) and 62 country-years with the Tenth Revision (ICD-10). These data are presented for cause groups according to the PAHO 6/61 List for tabulation of ICD-9 and the PAHO 6/67 List for tabulation of ICD-10 coded mortality. In addition, average annual mortality data with estimated rates are shown for 31 selected cause groups around 1980 and for the latest 3 years available.

The statistical information presented in the publication was prepared by PAHO's Special Program for Health Analysis, which was also responsible for the selection, tabulation and technical review of the data presented.



Online Publication

Guidelines for Surveillance, Prevention and Control of West Nile Virus

Due to the threat of spread of West Nile virus to the countries of the Region, based on the proceedings from the "West Nile Virus Surveillance Workshop" organized by PAHO at the Caribbean Epidemiology Center (CAREC) in Trinidad and Tobago in 2002, PAHO's general recommendations for the surveillance of the West Nile Virus are presented as summarized by its Communicable Diseases Program.

The guidelines' objective is the timely detection of West Nile virus activity in reservoir and vector populations in order to put in place the appropriate measures in terms of enhanced surveillance, transmission and vector control, as well as mass communication.

Background

In late summer 1999, the first human cases of West Nile virus encephalitis were reported in the United States. The discovery of virus-infected, overwintering mosquitoes during the winter of 1999–2000 led authorities to predict renewed virus activity for the coming spring, and to launch early season vector control and disease surveillance in New York City and surrounding areas at the beginning of the summer of 2000. These surveillance efforts were aimed at detecting and documenting West Nile virus infections in birds, mosquitoes, and horses, as well as in sentinel animals that could predict the appearance of the disease in humans. By August 2002, West Nile virus activity had been detected in 41 states and the District of Columbia in the United States and four Canadian provinces. West Nile virus has been detected in birds (more than 78 species), mosquitoes (14 species), horses, certain other mammals, and humans.

Epidemiological Surveillance

The populations in which surveillance should be implemented in countries where West Nile virus circulation has not been detected, *in order of priority*, are birds, mosquitoes, horses, and finally, humans.

1. Active Bird Surveillance

Active bird surveillance is aimed at monitoring arbovirus activity in free-ranging and sentinel birds. Surveillance of dead crows in particular and other members of the family *Corvidae* may be an indicator of West Nile virus in a geographic area. However, in some areas, other wild bird species may be the first birds identified with West Nile virus infection (Table 1).

This surveillance requires the collection of birds that have recently died (within less than 48 hours) and the shipment of their remains (preserved on ice in plastic bags) to the national reference laboratory.

2. Active Mosquito Surveillance

The purpose of mosquito surveillance is to identify potential vectors, monitor their population densities in a given area, and detect West Nile virus or other arbovirus activity. In 1999, the West Nile virus in the United States was found primarily in bird-feeding mosquitoes. In 2000, virus-infected, mammal-feeding mosquitoes were also found.

Entomological surveys should target mainly adult populations of *Culex spp.*, followed by surveillance of *Aedes spp.* and other species in areas where probable or confirmed cases have been reported in birds, animals, or humans, and in areas with a high risk of West Nile virus transmission, such as zoos, game reserves, nesting or feeding grounds of migratory birds. (Table 2).

3. Enhanced Passive Veterinary Surveillance

As a support system to detect the presence of West Nile virus and monitor the level of its transmission outside the bird-mosquito cycle, enhanced passive surveillance for neurological disease (passive surveillance enhanced by general alerts to veterinarians) should be implemented mainly in horses and other mammals.

This requires the investigation of cases in horses with neurological symptoms consistent with encephalitis (such as listlessness, ataxia, lack of coordination, staggering, drooping lower lip, partial paralysis, or death) and the shipment of serum and brain samples from these animals to the national reference laboratory for antibody detection and/or virus isolation . It is also useful to send formalin-preserved tissue from the brain and cervical medulla for histopathology. In some countries, it will be necessary to make a differential rabies diagnosis.

4. Enhanced Passive Human Surveillance

Enhanced passive surveillance for human cases of viral encephalitis (passive surveillance by alerting the health services) can be implemented as a backup system for the detection of West Nile virus activity. If resources permit, surveillance of aseptic meningitis should also be implemented.

The objective of human surveillance is to detect serious cases of West Nile virus infection in order to offer treatment.

Case Definitions

A **suspected case** is any person who presents clinical symptoms of fever and serious neurological manifestations (from aseptic meningitis or encephalitis) of unknown etiology.

A **probable case** is defined as a *suspected case* with one or more of the following criteria:

— demonstration of serum IgM antibody against West Nile virus using ELISA immunoenzyme assay (ELISA);

Table 1: Birds and Animal Species from which West Nile Virus has been isolated

Free-Ranging North American Species

Bittern, Least *Ixobrychus sinensis*
Blackbird, Red-winged *Agelaius phoeniceus*
Bluebird, Eastern *Sialia sialis*
Cardinal, Northern *Cardinalis cardinales*
Catbird, Gray *Dumetella carolinensis*
Chickadee, Black-capped *Poecile atricapillus*
Cormorant, Double-crested *Phalacrocorax auritus*
Cowbird, Brown-headed *Molothrus ater*
Crow, American *Corvus brachyrhynchos*
Crow, Fish *Corvus ossifragus*
Dove, Mourning *Zenaida macroura*
Duck, Mallard *Anas platyrhynchos*
Finch, House *Carpodacus mexicanus*
Flicker, Northern *Colaptes auroatus*
Goldfinch, American *Carduelis tristis*
Goose, Canada *Branta canadensis*
Grackle, Common *Quiscalus quiscula*
Grouse, Ruffed *Bonasa umbellus*
Gull, Great Black-backed *Larus marinus*
Gull, Herring *Larus argentatus*
Gull, Ring-billed *Larus delawarensis*
Hawk, Broad-winged *Buteo platypterus*
Hawk, Cooper's *Accipiter cooperii*
Hawk, Red-tailed *Buteo jamaicensis*
Hawk, Sharp-shinned *Accipter striatus*
Heron, Great Blue *Ardea herodias*
Heron, Green *Butorides virescens*
Hummingbird, Ruby-throated *Archilochus colubris*
Jay, Blue Cyanocitta cristata
Kestrel, American *Falco sparverius*
Killdeer *Charadrius vociferus*
Kingfisher, Belted *Ceryle alción*
Merlin *Falco columbarius*
Mockingbird, Northern *Mimus, polyglottos*
Titmouse, Tufted *Chordeiles minor*
Ovenbird *Seiurus aurocapillus*
Owl, Great Horned *Bubo virginianus*
Phoebe, Eastern *Sayornis phoebe*
Rail, Virginia *Rallus limicola*
Raven, Common *Corvus corax*
Robin, American *Turdus migratorius*
Sanderling *Calidris alba*
Skimmer, Black *Rynchops niger*
Sparrow, Song *Melospiza melodia*
Thrush, Hermit *Catharus guttatus*
Thrush, Wood *Hylocichla mustelina*
Turkey, Wild *Meleagris gallopavo*
Turnstone, Urdí *Arenaria interpres*
Veery *Catharus fuscescens*
Vulture, Black *Coragyps atratus*
Warbler, Blackpoll *Dendroica striata*
Warbler, Canada *Wilsonia canadensis*
Warbler, Yellow-rumped *Dendroica coronata*
Warbler, Black-throated Blue *Dendroica caerulescens*
Waxwing, Cedar *Bombycilla cedrorum*

Captive North American Bird Species

Crane, Sandhill *Grus canadensis*
Eagle, Bald *Haliaeetus leucocephalus*
Gull, Laughing *Larus atricilla*
Magpie, Black-billed *Pica pica*
Night-Heron, Black-crowned *Nycticorax nycticorax*
Owl, Snowy *Nyctea scandiaca*

Other Free-ranging Bird Species

Dove, Rock (pigeon) *Columba livia*
Pheasant, Ring-necked *Phasianus colchicus*
Sparrow, House *Passer domesticus*
Starling, European *Sturnus vulgaris*
Swan, Mute *Cygnus olor*

Exotic Species housed in Zoos

Cormorant, Guanay
Duck Bronze-winged
Flamingo, Chilean
Pheasant, Himalayan Impeyan
Tragopan Blythe's

Pet and other Domesticated Species

Cat
Dog
Rabbit, domestic
Horse
Chicken
Turkey, domestic
Peacock
Goose, domestic
Parakeet
Macaw, *Ara* spp
Cockatoo
Cockatiel
Finch

Free-Ranging Mammal Species

Bat, Big brown *Eptesicus fuscus*
Bat, Little brown *Myotis lucifugus*
Chipmunk, Eastern *Tamias striatus*
Raccoon *Procyon lotor*
Skunk, Striped *Mephitis mephitis*

— antibody in convalescent-phase serum screened by ELISA or hemoagglutination inhibition (HI) and confirmed by plaque reduction neutralization test (PRNT).

A **confirmed case** is a *probable case* with one or more of the following criteria:

— isolation of West Nile virus or demonstration of West Nile viral antigen or genomic sequences in tissue, serum, cerebrospinal fluid, or other body fluid;

— demonstration of seroconversion (a fourfold or greater increase in antibody titer) to West Nile virus in PRNT in serum or paired samples of cerebrospinal fluid (acute and convalescent);

— demonstration of IgM antibodies to the West Nile virus in a cerebrospinal fluid sample in the acute phase by MAC-ELISA.

***Note*:** Detection of IgM specific antibodies to West Nile virus and/or IgG antibodies (by ELISA) in a single serum or cerebrospinal fluid sample should be confirmed by any of the other previous techniques.

Prevention and Control Measures

Prevention

At the present time, the most effective way to prevent transmission of West Nile virus and other arboviruses to humans and other animals, or to control an epidemic once transmission has begun, is to reduce human exposure to the mosquito vectors. To prevent domestic animal and human disease, public health services must have adequate vector control capabilities.

A critical component of any program for the prevention and control of vector-borne disease transmission is public education about these diseases, how they are transmitted, and how to prevent or reduce the risk of exposure. Public education efforts should make use of behavioral science and social marketing methods to communicate the information effectively to the target populations.

There are some basic precautions that individuals may undertake to limit their exposure to the virus in their homes:

— Put screens on windows and block any holes in the house where mosquitoes can enter.

— Wear long pants and long-sleeved shirts, particularly when remaining outdoors for extended periods, especially at times when mosquitoes are active.

— Minimize outdoor activities at dawn and dusk, when mosquitoes are most likely to bite.

— Use insect repellents with up to 35% of the active ingredient DEET for adults and up to 20% for children.

Herbal and ultrasonic repellents are ineffective against mosquitoes.

Control

The most effective and economical way of controlling mosquitoes is by larval source reduction. Experience shows that this is best done through programs that reduce breeding sites, monitor mosquito populations, and initiate control measures before the disease is transmitted to humans and domestic animals. Such programs can also be used as the first-line emergency response for mosquito control in the event that viral activity is detected in a particular area or the disease is reported in humans. Control of adult mosquito populations through aerial spraying of insecticides is usually kept as a last resort.

In addition to preventing exposure to the mosquitoes, in the United States the Animal Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) has granted a provisional license for the use of a vaccine composed of killed virus for horses.

Table 2: Mosquito species from which the West Nile Virus has been isolated

Aedes albopictus	*Anopheles barberi*
Aedes vexans	*Anopheles quadrimaculatus*
Anopheles punctipennis	*Culex pipiens*
Coquillettidia perturbans	*Culex nigripalpus*
Culex restuans	*Culex salinarius*
Culex quinquefasciatus	*Ochlerotatus atlanticus*
Culiseta melanura	*Ochlerotatus canadensis*
Ochlerotatus atropalpus	*Ochlerotatus japonicus*
Ochlerotatus cantator	*Ochlerotatus taeniorhynchus*
Ochlerotatus sollicitans	*Ochlerotatus trivittatus*
Ochlerotatus tormentor	*Psorophora columbiae*
Orthopodomyia signifera	*Uranotaenia sapphirina*
Aedes cinereus	*Psorophora ferox*

Biosafety

Universal precautions for animal necroscopy should be employed, for example: personal protection (use of protective clothing, gloves, facial and eye protectors), sanitary disposal of dead birds and animals or contaminated samples, and the disinfection of all devices after processing the samples.

For the storage and transport of specimens, please refer to the WHO Biosafety Standards at the following Internet site: http://www.who.int/emc-documentos/bioseguridad/whoemc973c.html

Source: Prepared by the Communicable Diseases Program of PAHO's Division of Disease Prevention and Control (HCP/HCT). This information was adapted from the material used in the West Nile Virus Surveillance Workshop, held at CAREC in April/May 2002, with the support of the Centers for Disease Control and Prevention (CDC) of the United States, PAHO's Communicable Diseases (HCP/HCT), Veterinary Public Health (HCP/HCV), and Essential Drugs and Technology (HSP/HSE) Programs.

Summer Courses in Epidemiology in 2003

■ The Thirteenth Summer Session in Intermediate Epidemiology, sponsored by the Special Program for Health Analysis [as of March 2003, the Area of Health Analysis and Information Systems (AIS)] of the *Pan American Health Organization*, will take place from 21 July to 8 August 2003 at the College of Public Health of the University of South Florida in Tampa, Florida.

Courses offered are:
Intermediate methods in epidemiology
Statistics applied to epidemiology and the use of software packages
Use of epidemiology in the programming and evaluation of health services.

Students are required to have approved training in epidemiology. Courses will be conducted in Spanish, but participants must be able to read English. Applications must be received before 15 April, 2003.

For application and more information, contact: Ms. Clara Ochoa, Area of Health Analysis and Information Systems (AIS), Pan American Health Organization, 525 Twenty-third Street, NW, Washington, DC 20037. Tel: (202) 974-3508, Fax: (202) 974-3674. email: ochoacla@paho.org

■ The *Johns Hopkins Bloomberg School of Public Health* will hold its 2003 Graduate Summer Institute of Epidemiology and Biostatistics from June 16 to July 4, 2003. A total of 26 courses will be offered, ranging in length from one week to three weeks:

Three-week courses:
Principles of Epidemiology
Intermediate Epidemiology
Infectious Disease Epidemiology
Design and Conduct of Clinical Trials
Epidemiologic Basis for Tuberculosis Control
Statistical Reasoning in Public Health I
Statistical Reasoning in Public Health II

Two-week course:
Regression Analysis in Public Health Research

One-week courses:
Family Based Genetic Epidemiology
Introduction to the SAS Statistical Package
Multilevel Models
Molecular Biology for Genetic Epidemiology
Data Analysis Workshops I and II
Epidemiology in Evidence-Based Decisions
Ethics Issues in Human Subjects Research in Developing Countries
Nutritional Epidemiology
Genetic Epidemiology in Populations
Survival Analysis
Conducting Epidemiological Research
New Perspectives on Management of Epidemiologic Studies
Tobacco Control: National and International Approaches
Epidemiology of HIV/AIDS
Applications of the Case-Control Method
Epidemiologic Applications of GIS
Perinatal Epidemiology
Social Epidemiology
Epidemiologic Methods for Planning and Evaluating Health Services
Methods and Applications of Cohort Studies
Pharmacoepidemiology

For more information, contact: Ayesha Khan, Program Coordinator, Graduate Summer Institute of Epidemiology and Biostatistics, Johns Hopkins Bloomberg School of Public Health, 615 N. Wolfe Street, Baltimore, MD 21205, USA. Tel: (410) 955-7158, Fax: (410) 955-0863. Email: akhan@jhsph.edu, website: www.jhsph.edu/summerepi

■ *The University of Michigan School of Public Health* announces its *38th Graduate Summer Session in Epidemiology* from July 6-25, 2003. Courses offered are for all Public Health Professionals.

One and three-week courses include topics such as: Fundamentals of Biostatistics and Epidemiology, Infectious Diseases, Epidemiology in Public Health Practice, Cancer, Injuries, Clinical Trials, Computer Applications, Epidemiologic Measures, Logistic Model, Environmental and Occupational Epidemiology, Behavioral Change, Violence, Health Economics, Social Epidemiology, Longitudinal Studies, PC-SUDAAN, Global Health, Genetics, Bioterrorism: A New Challenge for the Public Health and Medical Community, Pharmacoepidemiology, and Women's Health Issues.

Special Weekend Courses are in: Introduction to Genetics in Epidemiology and Geographic Information Services.

CME Credit Available

For application and information contact: Jody Gray, Graduate Summer Session in Epidemiology, The University of Michigan, School of Public Health, 109 Observatory St., Ann Arbor, MI 48109-2029, USA, Telephone: (734) 764-5454 , Fax: (734) 764-3192, Email: umichgss@umich.edu, Website: www.sph.umich.edu/epid/GSS

■ *The Department of Epidemiology, Biostatistics, and Occupational Health of McGill University* will hold its 18th Annual Summer Program in Epidemiology and Biostatistics from May 5 to May 30 and from June 2 to June 27, 2003.

The program offers health professionals the opportunity to gain familiarity with the principles of epidemiology and biostatistics. Academic credits are available to graduate students, residents and fellows from McGill and other universities. Physicians with a license from Canada and USA can register for Continuing Medical Education (CME) units. In addition, physicians coming from outside Canada or USA, as well as health and other professionals can obtain a professional interest certificate. The language of instruction is English.

The **May session** (May 5 – 30) includes the following courses:

General topics: Introduction to Epidemiology (3 credits), Topics in Clinical Epidemiology (3), Statistical Inference I (2), Epidemiology of Cancer (1), Evidence-based Behavioural Medicine (1), and Understanding Risk Assessment in Clinical Medicine (1).

Clinical trials: Clinical Trials: Design & Analysis (1 credit).

The **June session** (June 2 – 27) includes:

General topics: Practical Aspects of Protocol Development (3 credits), Analysis of Multivariable Data (3), Statistical Inference II (2), and Evaluation of Complementary and Alternative Medicine (1).

Pharmacoepidemiology: PE II: Intermediate Pharmacoepidemiology (2 credits), PE III: Advanced Pharmacoepidemiology (2), and PE IV: Pharmacoeconomics (2).

Health Care Services Research: PE II: Intermediate Pharmacoepidemiology (2 credits), PE III: Advanced Pharmacoepidemiology (2), and PE IV: Pharmacoeconomics (2).

Public Health: Good Practice in Clinical Research (2 credits). and Data Security in Public Health: legal and technical aspects from an international perspective (1).

For more information, contact: Summer Coordinator, 2003 Summer Program in Epidemiology and Biostatistics, Faculty of Medicine, McGill University, Purvis Hall, 1020 Pine Avenue West, Room 38-B, Montreal, Quebec, Canada, H3A 1A2, Tel: (514) 398-3973, Fax: (514) 398-4503, email: summer@epid.lan.mcgill.ca; http://www.mcgill.ca/epi-biostat/summer/

■ The Twenty-first International Course in Applied Epidemiology, conferring diploma status recognized by the National Autonomous University of Mexico, will take place from 7 July to 1 August 2003 in Mexico, D.F., under the coordination of *the Department of Epidemiology of the Ministry of Health of Mexico*.

Courses are designed to provide training in two broad areas: theoretical and methodological aspects of epidemiological practice, and specific subjects of applied epidemiology.

They include:

Basic level: Epidemiology, Biostatistics, and EpiInfo.

Intermediate level: Epidemiology, Biostatistics, and Research Methodology.

Optional courses: Geography in Health, Clinical Epidemiology, Health Policy, and EpiInfo 2000.

Case-studies: Public Health Administration, MultivariateAnalysis, Health Economics, Public Health Management, and Epidemiologic Surveillance of non-Communicable Diseases.

For further information, please contact: Dirección General de Epidemiología, Francisco P. Miranda No. 177, Col. Unidad Lomas de Plateros, Delegación Obregón, C.P. 01480, México, D.F., Mexico. Tel: 55 93 36 61, Fax: 56 51 62 86, email: sarta@epi.org.mx, http://www.epi.org.mx.

Other Courses of Interest

■ The *Johns Hopkins Bloomberg School of Public Health* will hold its 2003 Graduate Summer Institute of Health Policy and Management from June 2 to 20, 2003. This summer institute is dedicated to strengthening the skills and public health knowledge of health professionals and public health practitioners. For further information, contact Pam Davis, Tel: (410) 614-1580, email: hpm-inst@jhsph.edu, http://www.jhsph.edu/dept/HPM/Non_Degree/institutes.

■ The Special Program for Health Analysis [as of March 2003, the Area of Health Analysis and Information Systems (AIS)] of the Pan American Health Organization (PAHO) and the Universidad Oberta de Cataluña (UOC) of Spain, are organizing the III Distance Learning Course on the Bases of Epidemiology and Biostatistics, offered in Spanish with a duration of six months, starting July 1, 2003.

The characteristic of this program is that it is based on the development of professional skills for the practice of epidemiology. Accordingly, the process of learning is oriented to the resolution of real-life problems addressed by professionals in their daily work. The course's thematic units are organized in 7 modules. Two of them are devoted to online learning methods and computational tools, while the rest includes concepts and fundamental methods of epidemiology and basic biostatistic tools required for the epidemiological analysis of the health status and its determinants.

Applications should include name, age, address, current position, degree, previous courses, and a recent photograph, in accordance with the application form (available at http://www.paho.org). Each student should have access to a computer and to the Internet. For additional information, please contact: Area of Health Analysis and Information Systems (AIS), Pan American Health Organization, 525 23rd Street, NW - Washington, DC 20037 U.S.A., email: sha@paho.org.

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