Mortality from Acute Respiratory Infections in Children under 5 Years of Age: Global Estimates

Introduction

Acute respiratory infections (ARI) have long been recognized as a leading cause of morbidity and mortality, especially among the very young and the very old.

The analysis of information available to WHO relating to the situation in the 1950s and 1960s published in 1973 (1) showed that ARI were among the most important causes of death in all age groups and particularly in children under 1 year of age. A more recent analysis of the problem (2) shows that in developed countries ARI are the cause of about 10 to 15% of all infant deaths and deaths in those over 65 years of age; they also account for around 30 to 40% of outpatient attendances and 20 to 30% of hospital admissions in these two age groups.

As regards developing countries, the available health services statistics and data from special surveys indicate that the magnitude of the ARI problem in terms of morbidity is more or less the same as in developed countries, but that mortality from ARI, particularly in infants and young children, may be 30 or more times higher than in developed countries. For most developing countries, however, data on mortality and on causes of death are lacking.

It is well known that while 65 to 75% of all deaths in developed countries are in persons 65 years and older, in developing countries 50% of all deaths are in children under 5, who represent 15% of the total population. In many developing countries the average life expectancy at birth is still around 50 years. The life expectancy of children who survive to age 1 increases to 56-57 years, and those who survive to age 5 enjoy a life expectancy of over 60 years, a level not markedly dissimilar from that of developed countries (3). For most developing countries, in fact, the levels of infant mortality and life expectancy are the only available estimates that can be used for delineating existing public health problems.

Infant mortality is widely recognized as a sensitive indicator of general health conditions and is often used as a substitute for or as an index of life expectancy. It may also indicate, although with limitations, the differences in the structure of mortality according to major causes of death due to differential fatality rates of various diseases, particularly in children from poor socioeconomic and environmental conditions. This certainly applies to deaths caused by acute respiratory infections.

In an attempt to estimate the global magnitude of mortality from acute respiratory infections in children under 5, an analysis was undertaken of data on reported deaths, mainly from developed countries, and of estimates concerning infant and early childhood mortality from the rest of the world, including, where available, the distribution of deaths according to major causes.

Estimates of the Annual Number of Infant and Child Deaths in the World

Although reliable data on the total number of deaths in children 0 to 4 years of age do not exist, an estimate based on available demographic information has been calculated as a basis for reference purposes to provide a global estimate of ARI-related deaths.

Infant mortality is one of the indicators available for nearly all countries, mostly as an estimate based on surveys or indirect methods of measurement. UNICEF publications (4, 5) present these estimates on infant mortality together with other relevant indicators, including estimates of total number of deaths in children under 5. A summary of these data is presented in Table 1, with countries grouped according to infant mortality levels. Estimates of the annual number of births and of the child populations in the 1 to 4 age group are also given. The figures refer to 1981, the year for which data on ARI-related deaths from 39 reporting countries were available.

The figure of 10 million deaths per year in infants and another 4.6 million in children 1 to 4 years, or 40,000 daily deaths of children under 5 is, most probably, a reasonable estimate. Gwatkin (6), for example, prepared a set of estimates based on the most recent and authoritative data available and concluded that during the late 1970s the range of the annual number of infant and child deaths in the world would be from 12 to 13 million to about 17 to 18 million, with an average of around 15 million.

For many years to come, this type of estimate of the magnitude of childhood mortality will be the only one...
Table 1. Annual number of deaths in children 0 to 4 years according to levels of infant mortality (global figures for 1981).

<table>
<thead>
<tr>
<th>Level of infant mortality (per 1,000 live births)</th>
<th>Number of countries</th>
<th>Estimated total population (millions)</th>
<th>Estimated births per year (millions)</th>
<th>Estimated child population 1-4 years (millions)</th>
<th>Estimated global number of deaths (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 and less</td>
<td>51</td>
<td>1,127</td>
<td>16.0</td>
<td>67.5</td>
<td>0.3</td>
</tr>
<tr>
<td>26-50</td>
<td>27</td>
<td>1,451</td>
<td>31.3</td>
<td>122.0</td>
<td>1.3</td>
</tr>
<tr>
<td>51-75</td>
<td>9</td>
<td>190</td>
<td>31.3</td>
<td>122.0</td>
<td>2.1</td>
</tr>
<tr>
<td>76-100</td>
<td>20</td>
<td>470</td>
<td>31.3</td>
<td>122.0</td>
<td>1.6</td>
</tr>
<tr>
<td>101-125</td>
<td>18</td>
<td>1,110</td>
<td>41.2</td>
<td>120.0</td>
<td>1.6</td>
</tr>
<tr>
<td>126 and over</td>
<td>25</td>
<td>252</td>
<td>11.6</td>
<td>33.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>4,600</td>
<td>124.0</td>
<td>420.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Available. It must be borne in mind that more than 40% of the world's infants and nearly 40% of the world's children 1 to 4 years old live in countries with an infant mortality level of 100 and more per 1,000 live births, and where no data whatsoever exist in regard to vital events. There is little doubt that the very high infant and childhood mortality in these countries results from the combined effect of infections, parasitic, diarrhoeal and respiratory diseases on the one hand, and of nutritional deficiencies on the other hand. The same holds true for many countries with infant mortality levels between 50 and 100 per 1,000 live births.

**ARI-related Deaths in Countries Reporting Causes of Death**

Data on ARI-related mortality in children under 5 were tabulated for 39 countries reporting causes of death given separately for infants and children 1 to 4 years old. The following causes of death, according to the Ninth Revision of the International Classification of Diseases, were considered as ARI-related deaths: tuberculosis, diphtheria, pertussis, measles, otitis media, upper respiratory tract diseases, other respiratory tract diseases, acute bronchitis and bronchiolitis, pneumonia, influenza, and pleurisy. The year to which most of the reported data referred was either 1979, 1980 or 1981, but in a few instances figures for 1982 or 1983 were available. However, the differences in the annual number of deaths reported, if available for several of the above years, were very small, and it can be assumed that the data presented here represent the annual number of ARI-related deaths in children under 5 reported in 1981.

Among the 39 countries for which data on causes of death were available for computation were: Canada and the United States (Northern America), 11 Latin American and Caribbean countries (Argentina, Chile, Costa Rica, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Panama, Paraguay and Peru), 8 countries/territories from Asia (Hong Kong, Israel, Japan, Kuwait, Singapore, Sri Lanka, Syrian Arab Republic and Thailand), Australia and New Zealand (Oceania), and 16 European countries (Austria, Belgium, Bulgaria, Czechoslovakia, France, Federal Republic of Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, Rumania, United Kingdom, and Yugoslavia).

The total number of reported ARI-related deaths in these 39 countries was 111,877, of which 74,268 (66.4%) were in infants and 37,609 (33.6%) in children 1 to 4 years old. All these deaths are presented in Table 2, with countries grouped according to level of infant mortality.

Although nearly two-thirds of the 39 reporting countries belong to the group with an infant mortality level of 25 per 1,000 live births or less, the differences in the ARI death rates are striking. ARI death rates range from 0.85 to 4.75 per 1,000 infants, and from 0.06 to 0.39 per 1,000 children 1 to 4 years old. Death registration in all these countries has to be considered as complete, according to the accepted definition of completeness, i.e., 90% or more of all deaths are recorded. The same range of differences in ARI death rates is seen in the remaining one-third of reporting countries with higher levels of infant mortality. Here, however, the completeness of vital registration may be questioned. In many Latin American countries, for example, which represent the majority of this second group of reporting countries, despite fairly complete death registrations, serious defects exist in the registration of causes of death, with a sizeable percentage of deaths assigned to ill-defined causes.
Table 2. ARI-related deaths in children 0 to 4 years in 39 countries or areas reporting causes of deaths, according to level of infant mortality (in or around 1981).

<table>
<thead>
<tr>
<th>Level of infant mortality (per 1,000 livebirth)</th>
<th>Reporting countries/areas</th>
<th>Number of countries/areas</th>
<th>Number of births per year (thousands)</th>
<th>Total Number of population (millions)</th>
<th>Child population 0-4 years (millions)</th>
<th>Reported ARI-related deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Absolute figures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>In infants</td>
</tr>
<tr>
<td>Northern America</td>
<td>United States, Canada</td>
<td>2</td>
<td>256.5</td>
<td>4,100</td>
<td>20.3</td>
<td>3,483</td>
</tr>
<tr>
<td>Central America</td>
<td>Costa Rica</td>
<td>1</td>
<td>2.4</td>
<td>74</td>
<td>0.3</td>
<td>352</td>
</tr>
<tr>
<td>Asia</td>
<td>a) Hong Kong, Japan, Singapore</td>
<td>3</td>
<td>126.0</td>
<td>1,638</td>
<td>9.0</td>
<td>2,003</td>
</tr>
<tr>
<td>Oceania</td>
<td>b) Israel, Kuwait</td>
<td>2</td>
<td>5.5</td>
<td>154</td>
<td>0.8</td>
<td>732</td>
</tr>
<tr>
<td>Europe</td>
<td>Australia, New Zealand</td>
<td>2</td>
<td>18.3</td>
<td>296</td>
<td>1.5</td>
<td>291</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>23</td>
<td>753.1</td>
<td>10,899</td>
<td>54.3</td>
<td>18,540</td>
</tr>
<tr>
<td>26-50</td>
<td>Americas</td>
<td>4</td>
<td>46.1</td>
<td>1,183</td>
<td>4.9</td>
<td>8,804</td>
</tr>
<tr>
<td>26-50</td>
<td>Asia</td>
<td>2</td>
<td>63.9</td>
<td>1,817</td>
<td>8.5</td>
<td>7,831</td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td>3</td>
<td>55.2</td>
<td>945</td>
<td>4.6</td>
<td>15,722</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>9</td>
<td>165.2</td>
<td>3,945</td>
<td>18.0</td>
<td>32,357</td>
</tr>
<tr>
<td>51 and over</td>
<td>Americas</td>
<td>6</td>
<td>46.9</td>
<td>1,800</td>
<td>7.6</td>
<td>22,873</td>
</tr>
<tr>
<td>51 and over</td>
<td>Asia</td>
<td>1</td>
<td>9.5</td>
<td>443</td>
<td>1.8</td>
<td>498</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>39</td>
<td>974.7</td>
<td>17,087</td>
<td>81.7</td>
<td>74,268</td>
</tr>
</tbody>
</table>

Table 3 shows the percentage distribution of ARI-related deaths in children in 39 reporting countries, according to specific causes of death. It can be seen that even within these causes the highest proportion is attributed to "other respiratory tract diseases".

The known magnitude of ARI-related mortality in developed countries represents only a fraction of its global magnitude. It cannot be assumed that unregistered deaths, or even those due to ill-defined causes, have the same distribution as the ones which have been reported and for which the cause of death has been determined.

**Worldwide Mortality from ARI**

The figures for ARI-related deaths from 39 countries reporting causes of death, presented in Table 2, are certainly not representative, since these countries comprise only 21% of the total world population, 18% of the total number of children 0 to 4 years old, and 14% of infants born each year. For the rest of the world reliable...
Table 4. Estimated annual number of ARI-related deaths in children 0 to 4 years, according to level of infant mortality (global figures for around 1981).

<table>
<thead>
<tr>
<th>Level of infant mortality</th>
<th>Number of countries</th>
<th>Number of infants (millions)</th>
<th>Number of children 1-4 years</th>
<th>Estimated ARI-related deaths Rates per 1,000</th>
<th>Absolute figures (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 and less</td>
<td>51</td>
<td>16.0</td>
<td>67.5</td>
<td>2.5</td>
<td>40</td>
</tr>
<tr>
<td>26-50</td>
<td>27</td>
<td>31.3</td>
<td>122.0</td>
<td>8.0</td>
<td>470</td>
</tr>
<tr>
<td>51-75</td>
<td>9</td>
<td>6.5</td>
<td>21.7</td>
<td>16.0</td>
<td>130</td>
</tr>
<tr>
<td>76-100</td>
<td>20</td>
<td>17.4</td>
<td>55.8</td>
<td>25.0</td>
<td>435</td>
</tr>
<tr>
<td>101-125</td>
<td>18</td>
<td>41.2</td>
<td>120.0</td>
<td>28.0</td>
<td>1,154</td>
</tr>
<tr>
<td>126 and over</td>
<td>25</td>
<td>11.6</td>
<td>33.0</td>
<td>30.0</td>
<td>348</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>124.0</td>
<td>420.0</td>
<td>2,577</td>
<td>1,442</td>
</tr>
</tbody>
</table>

data on causes of deaths are either very limited or nonexistent.

The differences in ARI death rates among reporting countries however, together with other published data on ARI-related deaths in children, seem to present a reasonable basis for an assessment of the worldwide magnitude of ARI-related mortality in children under 5. Table 4 presents the results of such an assessment in which ARI death rates were applied to the world child population grouped according to level of infant mortality.

The figure of 4 million ARI-related deaths per year in children under 5 may well be an underestimation rather than an overestimation, as the ARI death rates used for calculations might be lower than the actual ones. This is certainly the case for some countries with a very high overall level of infant mortality.

The limited data published on ARI-related deaths show vast differences in levels of mortality. For example, in Peru, with regard to influenza and pneumonia only, the level of mortality is 37 times higher in infants and 43 times higher in children 1 to 4 years than in Canada or the United States (7). In the Philippines these rates are 24 and 73 times higher, respectively, for infants and children 1 to 4 years than in Australia (8). Other examples of these differences in mortality from influenza and pneumonia, only between selected developed and developing countries, have been presented by Pio et al. (2). All these examples relate to countries with an infant mortality level below 100 per 1,000 live births, and there is no doubt that similar, if not still higher, differences must exist between countries with overall infant mortality above 100 per 1,000 live births and those below 50 per 1,000.

The margin of error, however, cannot be very high in view of the fact that the figure of 4 million deaths due to ARI represents 27% of all deaths in this age group. The same proportion of ARI-related deaths to total deaths in children under 5 was found in a few mortality surveys currently undertaken by the WHO Program on ARI in selected areas of developing countries. The same proportion has also been reported by Bulla and Hitze (9).

Discussion

As far back as 1960, a Committee of the American Public Health Association (10) stated that "...in an oversimplified fashion four levels of public health concern and effort can be delineated: (1) mortality, (2) serious morbidity, (3) minor morbidity, (4) positive health". The Committee saw the United States in 1960 as ready for level (3), and used acute respiratory infections, among others, as an example of minor morbidity. Using the same oversimplified classification to delineate public health problems in developing countries in the 1980s, there is full consensus that all these countries are still at level (1), and that traditional health indicators, such as infant mortality and life expectancy, remain most useful.

For most developing countries, in fact, these indicators are the only ones available, and this explains why the level of infant mortality has been used as a basis for the global assessment of ARI-related deaths. The limited evidence available seems to indicate that there is a relationship between the level of infant mortality and ARI-related deaths.

In the developed countries there has been a steady decline over the last 20 to 30 years in both infant and childhood mortality as well as in the rates of deaths due to respiratory diseases.

Some developed countries have recently reached the
level of infant mortality of 7 to 8 per 1,000 live births, considered the lowest possible limit of infant mortality under the present state of the art of medicine. In regard to ARI-related deaths, data presented in the Joint United Nations and World Health Organization Study on Levels and Trends of Mortality since 1950 (3) as well as in several other publications (2, 11) confirm that between the 1950s and 1970s death rates due to respiratory diseases were reduced by more than 50% in infants and by more than 60% in children 1 to 4 years old.

For more developed countries it was also found that there is a close relationship between infant mortality and GNP per capita. The coefficient of correlation is -0.89 (3). This degree of correlation is impressive as it is well known that the value of GNP per capita does not take into account differences in the international distribution of income, or differential levels of government spending on health and welfare items, both of which could be expected to influence mortality levels (3). Due to lack of data, such a relationship cannot be assessed for developing countries, although there is little doubt that it exists there too. Survey data from some developing countries indicate huge within-country differences in the levels of infant and childhood mortality. In some countries, children from urban areas experience lower mortality than rural children. This may be particularly true for infant mortality which, in some developing countries, was found to be 40% higher in rural than in urban areas. It was claimed that better access to health facilities in urban areas, with a ratio of physicians and hospital beds per population ten times higher on average, may be responsible for this difference.

It was found that childhood mortality was twice as high when mothers had no education compared to mothers with elementary education, and four times as high when compared to mothers with secondary education. Obviously, many factors contribute to an extremely high level of mortality in children, particularly infants from lower socioeconomic groups in developing countries: poor nutrition, low income, poor environmental sanitation and personal health practices, inadequate preventive health measures and inaccessibility of health facilities. Culturally determined attitudes with respect to health and medical care also contribute to the high level of infant and childhood mortality observed among the poorest classes, in addition to poverty and privation. Often there is a lack of knowledge and awareness of health problems among these groups.

Differences in socioeconomic conditions within developing countries imply the coexistence of population groups enjoying radically different mortality levels. The lower socioeconomic groups, apart from outnumbering the better-off, have the highest fertility, so that the overall level of infant and childhood mortality is declining very slowly, if at all, in those countries. The limited evidence available also seems to indicate that in most developing countries the rate of decline in ARI-related deaths is small or nonexistent.

**Conclusion**

Although the inadequacy of existing health information systems worldwide is well known, the limited data available on ARI-related deaths in children under 5 clearly indicate the magnitude of the problem. Out of nearly 15 million children under 5 dying each year, 4 million die of acute respiratory infection, and two-thirds of both these figures are infants. More than 90% of all these deaths occur in developing countries where children under 5 represent about 15% of the total population and contribute to over 50% of all deaths. In all these countries, acute respiratory infections together with diarrhoeal diseases and malnutrition constitute the main cause of high childhood mortality. This presents a strong rationale for focusing the attention of the WHO ARI program on deaths among children under 5.

**References**


Epidemiological Activities in the Countries

Meeting in Costa Rica on a Program to Strengthen Epidemiological Instruction in Schools of Public Health

From 23 to 25 July 1986 representatives from PAHO/PASCAP and some Latin American schools met in San José, Costa Rica, in order to draw up a plan for strengthening epidemiological instruction, which will initially focus on the Schools of Public Health of Rio de Janeiro, Medellín and Mexico City. The project, sponsored by PAHO/WHO, includes the development of a network of national and regional epidemiologic research centers that will constitute the unifying axis of the program, under which schools and health services will work in collaboration. The program, which will begin in the three aforementioned schools, will gradually be extended to others.

With the recommendations of the Buenos Aires Seminar on the Uses and Prospects of Epidemiology as a frame of reference, the essential features of teaching practice in Brazil, Colombia, and Mexico were examined at the meeting. Proposals prepared by these countries were discussed with a view to devising a plan of work for the short term.

The delegation of Brazil presented the recommendations of the Seminar on Epidemiology Applied to Health Services recently held at Itaparica and stressed the need to concentrate on health professionals holding higher degrees. Brazil’s proposal also calls for a) the preparation of teaching materials and organization of bibliographical support; b) a survey of manpower resources in epidemiology; c) the identification and support of teaching units that are part of research and service establishments, and d) periodic surveys and meetings for continuing education and program evaluation.

The proposal made by Colombia focuses on a) the need to train 150 additional epidemiologists in the near future (target established by the National Meeting of Epidemiologists held in Medellin from 21 to 22 April 1986); b) the need to use epidemiology in the planning and administration of health services, and c) the conduct of research programs through the urban units of Barranquilla, Cali, Bucaramanga, Bogotá, and Medellín. As a short-run strategy, it proposes the organization of national-level seminars on subjects of interest to the country (general mortality, chronic diseases, accidents and violence, drug addiction, the evaluation of health services, and others).

The proposal put forward by Mexico has five major components: a) a national continuing education program based on regional networks; b) strengthening of master’s degree programs in epidemiology; c) the design of teaching and reference materials; d) promotion of instruction standardization workshops for educators, and e) research projects.

As a result of these proposals, it was necessary to extend the period originally set aside for diagnosing personnel training needs in epidemiology. Features common to the proposals of the three countries are concern for the training of personnel at the regional and intermediate levels, research-based instructions; emphasis on the use of epidemiology in the evaluation of services, and finding the means to provide continuing education for personnel previously trained.

Establishing and developing a regional network implies the countries’, as well as PAHO’s commitment to institutional strengthening (appraisal of public health schools, inventorying of resources, development of the schools’ capabilities to provide technical cooperation, and an information and documentation system); academic strengthening (exchanges of faculty among schools, teacher training, and the development of methodological and technological infrastructures); development of training proposals (policy, service and operational elements for project development, types of manpower, and evaluation indicators), and the