

Report of the International Conference on the Perinatal and Infant Mortality Problem of the United States / under the sponsorship of the National Center for Health Statistics, Public Health Service, U.S. Department of Health, Education, and Welfare.

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STATISTICS

Series 4
Number 3

Report of the
**International Conference
on the Perinatal and Infant
Mortality Problem of the
United States**

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service



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VITAL and HEALTH STATISTICS

DOCUMENTS AND COMMITTEE REPORTS

**Report of the
International Conference
on the Perinatal and Infant
Mortality Problem of the
United States**

Summary of the presentations and discussions at the International Conference on the Perinatal and Infant Mortality Problem of the United States, Washington, D.C., May 13 and 14, 1965, under the sponsorship of the National Center for Health Statistics, Public Health Service, U.S. Department of Health, Education, and Welfare.

Washington, D.C.

June 1966

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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Secretary

Public Health Service
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IN THIS REPORT a summary of the international conference on the perinatal and infant morbidity and mortality problem in the United States is presented. The conference was held in Washington, D.C., on May 13 and 14, 1965 under the sponsorship of the National Center for Health Statistics. The major findings of studies presented at the conference by investigators from Denmark, England and Wales, the Netherlands, Norway, Scotland, and the United States are summarized here. Trends over the past 30 years as well as the current situation in perinatal and infant mortality are described. Statistical, social, demographic, and medical artifacts associated with infant mortality are discussed in an effort to determine the reasons for the mortality differences between the United States and the Western European countries. Suggestions are made for future study of various aspects of the infant mortality problem.

The infant mortality rates have decreased impressively during the past 30 years; however, in the 1950's the rates of decline for four of the countries, including the United States, slowed down. The rate of decline in the United States decreased the most, and the deceleration started earlier than it did in most of the other countries. The infant mortality rates in Denmark and the Netherlands are still declining with no apparent interruption.

Large reductions in infant deaths have been attributed to declines in infectious disease mortality. There have been limited reductions in deaths from diseases of early infancy and congenital malformations, and an increasing incidence of perinatal deaths attributed to disorders of uncertain etiology. All investigators described increasing use of hospitals for delivery. There has been an increasing incidence of low-birth-weight infants in the United States. In countries where some measure of socio-economic level is available infant mortality is higher in the lower classes, and the mortality differential between the upper and lower classes is increasing.

Comparison of statistical, demographic, and medical parameters of infant mortality showed no clear-cut explanation of the significant international differences. Further research of infant and perinatal mortality problems was urged.

SYMBOLS

Data not available-----	---
Category not applicable-----	...
Quantity zero-----	-
Quantity more than 0 but less than 0.05----	0.0
Figure does not meet standards of reliability or precision-----	*

REPORT OF THE INTERNATIONAL CONFERENCE ON THE PERINATAL AND INFANT MORTALITY PROBLEM OF THE UNITED STATES

Elizabeth W. Curran, *Office of Health Statistics Analysis*

INTRODUCTION

Two features were noted about the infant mortality rate in the United States in the 1950's: (1) the virtual halt in the rate of decline of infant mortality after a long period of rapid decline,¹ and (2) the unfavorable position of United States' infant mortality compared with that of many other countries.² These two points were viewed with concern because health authorities had for many years pointed with pride to the high rate of decrease in infant mortality in the United States. In an attempt to illuminate the problem areas related to infant mortality in the United States, a comprehensive study of perinatal and infant mortality in several Western European countries of similar social and economic development was arranged. These countries were Denmark, England and Wales, the Netherlands, Norway, and Scotland. They were selected because of the low infant mortality rates in these countries over a long period of time, and because of the well-developed vital statistics systems with relatively stable definitions and reporting requirements.

The National Center for Health Statistics sponsored, on May 13 and 14, 1965, a conference on the perinatal and infant mortality problem of

the United States. The participants included the foreign investigators and various workers in the United States concerned with the problem of infant mortality. The purpose of the conference was to determine the reasons for the position of the infant mortality rate in the United States.

Following is a summary of the conference proceedings.

GREETINGS

Dr. Forrest E. Linder

In one respect this meeting is a rather unique event for the National Center for Health Statistics. The Center and its component parts have had a long history of meetings on a national basis with some international participation for considering questions of mortality classification and other technical questions related to the whole range of health statistics. However, this is the first time that we have called together an international group that is focusing its work on the meaning of United States figures, and on whether the apparent substantive indications of the numbers have validity in terms of interpretations that might be given to them. I think this is a forward step in our program in the National Center for Health Statistics and I hope it is a precursor of other fruitful conferences of this kind in the future.

We will look upon this conference as establishing a pattern which we hope to repeat, and which we hope will be effective in bringing about closer collaboration between the statisticians in

¹Moriyama, I. M.: Recent change in infant mortality trend. *Pub. Health Rep.* 75:391-405, May 1960.

²Shapiro, S., and Moriyama, I. M.: International trends in infant mortality and their implications for the United States. *Am. J. Pub. Health.* 53:747-760, May 1963.

this country and those in countries that have similar types of problems in vital and health statistics.

It is not on the agenda of this meeting to discuss what might be done in a public health program about findings shown by the figures or the causative situations that are indicated by our discussions here. The problem is to explore the validity and the meaning of the infant mortality rate in the United States to see whether the comparisons of that figure with other countries are technically valid, and to what extent the discrepancies and the differences are attributable to either technical questions or to social, demographic, or economic features. It will then be the responsibility of program directors in the various public health and medical agencies to develop required and appropriate action programs.

OPENING REMARKS

Dr. Iwao M. Moriyama,
Chairman

Up to about 15 years ago, the infant mortality rate in the United States was among the lowest in the world. In the period 1935 to 1950, the infant mortality rate declined at an accelerated pace in the United States and in other countries of low mortality, but in the 1950 decade, the rate of decline of infant mortality in the United States began to slow down. Incidentally, the change in mortality conditions was not peculiar to the period of infancy. The rate at other ages also leveled off in the United States, but these changes came several years after the beginning of the deceleration in the infant mortality rate.

The rapid decline in the infant mortality rate in the late 1930's and the 1940's appears to be due mainly to a reduction in deaths from the infective diseases. This was also generally true for the older ages. Although further reductions in the death rates for the infective diseases are still possible, the gains to be made through infectious disease control are limited. However, the infant mortality rate for the United States would be about 20 percent lower today if deaths from pneumonia had been eliminated.

One of the intriguing questions is why the rate of decline of infant mortality rates for countries such as the United States, England and Wales, and Norway has been checked, whereas the rates for Denmark and the Netherlands have continued to decline without apparent interruption.

This situation would not be too surprising if the level of the rate for Denmark and the Netherlands were considerably higher than that for the other countries; however, the contrary is true. Indeed, the recorded infant mortality rate for the Netherlands is now among the lowest in the world. If the present movement of the death rates were to continue, there would be no question in the future as to the country with the lowest perinatal and infant mortality rates.

Obviously, the decline in mortality rates cannot continue indefinitely; at some point the irreducible minimum must be reached. The irreducible minimum is anybody's guess, but it is significant to us that the recorded infant mortality rate for the Netherlands at this point in time is about 15 per 1,000 live births, whereas the rate for the United States is about 25. The position of the United States has worsened in relation to that of other countries. What is more, the gap is widening.

I find this to be a distressing situation only if it means that this country is suffering unnecessary infant loss, and one of our main tasks here is to determine whether international differentials in mortality are real or apparent. We need to take a critical look at the situation and rule out, as far as possible, the effects of artifacts on the comparisons. If the observed differences are real, we would like to identify the reason for the differences, and if we are unable to determine the reasons for the differences—and this is likely in many cases—I hope that we can suggest studies that will provide the answers.

It seems to me that there are two promising leads that should be examined concerning the problem of the relatively high infant mortality rate in the United States. One relates to the difference between the rates for the United States and those of other countries. The other relates to the marked decrease in the rate of decline for the infant mortality rate in the United States. Either or both of these factors might provide the reasons for the present unfavorable international position of the United States with respect to the infant mortality rate.

MAJOR FINDINGS OF THE FOREIGN STUDIES

Scotland

Dr. Charlotte A. Douglas

In Scotland there had been impressive declines in maternal, fetal, and infant mortality from 1935 until the early 1950's when the decline in the mortality rates became more gradual. Since then there have been only slight improvements. Dr. Douglas attributed the decline to the comparatively low birth rate plus the increased availability and utilization of maternity hospitals and maternal and child care. Today, 80 percent of the live births, 90 percent of the fetal deaths, and 90 percent of the premature births are delivered in maternity institutions. The average stay in the hospital is 9 days.

Fetal death registration was instituted in 1939, and since then the fetal death rate has decreased 55 percent. Improvement has been greatest for deaths due to difficult labor, ill-defined conditions, and toxemias.

In general, neonatal mortality is the result of intra-uterine conditions and birth hazards. These causes are responsible for 98 percent of first-day deaths, 95 percent of first-week deaths, and 90 percent of first-month deaths. Postneonatal mortality, however, is chiefly caused by respiratory diseases and congenital abnormalities.

Illegitimacy in Scotland is more a social problem than a medical one. Now, the illegitimacy ratio is 5.2 percent of live births. Although these children are a social problem which may persist in following generations, the effect on the overall infant mortality rate is comparatively low.

Dr. Douglas placed great emphasis on the relationship between social class and fetal and infant mortality. For statistical purposes, the social class of the infant is determined by the father's occupation. There are five defined classes, ranging from professional and managerial occupations (class I) to unskilled workers (class V). Although the infant mortality rates in all five classes have declined over the past 30 years, the distinction between classes I and V has widened. In 1939, the fetal death rate of class V

was $1\frac{1}{4}$ times as high as that of class I; in 1963, it was about $2\frac{1}{3}$ times as high as that of class I. Neonatal mortality shows a similar trend in class distinction. In 1939, class I had a neonatal mortality rate of 25.9 and class V of 39.9, whereas in 1963, class I had a neonatal mortality rate of 9.5 and class V of 22.3. The gap between these two social classes is greatest in the post-neonatal period; and instead of closing, this gap has widened throughout the years, for in 1939, the deaths in class V were 6 times that of class I, whereas in 1963 they were 13 times as great.

The Scottish Registrar General's Report for 1943 included an appendix analyzing infant mortality and fetal deaths by social class for the year 1939. Another tabulation was published in the report for 1944, and these statistics have been published every year since then. In 1943 Professor Richard Titmuss drew attention to the inequalities in infant mortality rates in the different social classes. His findings were confirmed by Morris and Heady in 1956. In France, similar mortality differentials were found by Croze, and in Hungary by Gzabady.

For some time in Aberdeen, Baird, Kincaid, and others have been working on the problem of reproductive efficiency and have established the fact that there is an association between maternal stature and pregnancy outcome. The measure of maternal stature was used as an index of the "biological fitness" of the mother. They have shown that for each social class, as a general rule, the taller the woman the less likely is she to produce a fetal death or an early neonatal death.

This tendency to show a widening difference between the social classes is difficult to understand in a country where medical care is available to all and where there is ample maternity hospital accommodation for any woman requiring expert care. It is true that the more intelligent women tend to seek prenatal care earlier in pregnancy than do women who may be careless about their health, and who are also overburdened with heavy household duties and the care of other children. This situation, might be expected to explain to some extent the differing mortalities between the classes, since antenatal care, however good, cannot be the whole explanation. It is true that family size with the concomitant extra burdens on the mother can be exhausting.

Should the pregnancies be too rapid, depletion of the mother's reserves of iron may lead to biological and physical exhaustion. However, only about 11 percent of the women in this country now have more than four children, and the average family size is only 2.5 children. So, some further explanation must be sought.

It would appear that the woman's growth is influenced not only by heredity but also by nutrition, housing, economic conditions, and the way of life of her parents. It has been found that there is a relationship between the number of siblings in the mother's parental house and her future reproductive capacity. In nonmanual workers there is an increase in perinatal mortality only when the mother was one of five or more children; while in the unskilled classes there is an increase when the mother had only one sibling.

These facts appear to lead to the generalization that the smaller the family the better will be the education and upbringing of the future mother. There is also a continual process of social selection and the usual tendency is for the average woman to rise out of her social class or remain within it. In this way, as the women with better reproductive potentialities move upwards, those remaining in classes IV and V are biologically and physically less able to produce and rear children successfully. Probably as these lower classes lose more and more women who are reproductively efficient, the perinatal and infant mortality rates will remain above the average.

England and Wales

Dr. Katherine M. Hirst

In England and Wales the total infant mortality has declined through the years, but it began to level off during the 1950's as did that of the United States. Perinatal mortality began to level off at the end of the 1940's; but in the midfifties fetal mortality began to fall again, while first-day mortality remained stationary. Postneonatal mortality appeared to start rising in the midfifties.

Three main causes of death were discussed— infections, diseases of early infancy, and congenital malformations. Infant mortality from infections has decreased steadily since 1935. While, in general, deaths from infective conditions continued to lessen during the 1950's, deaths from pneumonia and bronchitis and from gastro-

enteritis stopped declining and began to level off around 1957.

Diseases of early infancy, which include immaturity, birth injuries, and asphyxia and atelectasis, are responsible for 75 percent of first-day mortality. In this cause group, immaturity appears to be a strong factor in neonatal deaths, as half of the deaths ascribed to birth injuries and two-thirds of those ascribed to asphyxia are associated with immaturity. There has been no decline in first-day deaths (mainly caused by diseases of early infancy) since 1950.

There has been virtually no change in the mortality rate for congenital malformations during the fifties.

Low-birth-weight babies constitute one of the important high-risk components of infant mortality. In England and Wales the proportion of babies weighing 2,500 grams or less at birth is about 6.6 percent of all live births. This percentage has remained unaltered for the past 10 years. Also, the proportion of babies weighing 1,500 grams or less at birth has remained at 11 percent of the total of low-birth-weight babies for the past 10 years. Neonatal mortality of low-birth-weight babies has decreased from 155 neonatal deaths per 1,000 live births of 2,500 grams or less in 1953 to 128 in 1963; however, mortality of infants under 24 hours old has remained almost at a standstill.

There are geographical factors in infant and perinatal mortality in England and Wales, in that there is a southeast to northwest gradient with the lower fetal and infant mortality rates in the southeast. However, the gap is gradually closing. The urban and rural areas both show this southeast to northwest gradient.

As in Scotland, there is a fairly steep gradient from socioeconomic class I to socioeconomic class V which does not seem to be narrowing. Despite the fact that the gap between the incomes within these classes has been decreasing, the differences in the infant mortality rates between classes I and V have increased slightly. Dr. Hirst pointed out that one reason for the widening disparity is that cultural customs of a group do not necessarily change as rapidly as do economic situations. One of the most important steps in lowering infant mortality is the acceptance of new ideas, such as receiving antenatal care early in pregnancy or being hospitalized for birth;

however, changes in attitudes and ways of life take time.

Migration between classes may tend to keep the disparity evident. For example, families with poor health may drift into the lower socioeconomic classes. On the other hand, in connection with the maternal stature and infant mortality correlations discussed by Dr. Douglas, the woman who marries into a higher social class will, on the average, be taller, will have a better standard of education, and, if she is working, will have a better occupational status than the woman who marries into a lower social class. These attributes carry a lower perinatal mortality.

In conclusion, Dr. Hirst pointed out that the future outcome of pregnancy will depend on two views—the long-term view, which is the generation effect of a mother's background, and the short-term view, which uses parameters of pregnancy to define the immediate risk to the mother. It is important to realize that the immediate risk is evident because of the mother's background. At any one point in time the mother's background cannot be changed, but action can be taken to minimize the immediate risks involved in parturition. For England and Wales this means selection for hospital confinement. At present, 65 percent of the pregnant women are hospitalized for birth. This is the national average, with wide local variations. On the basis of high risk groups—women over the age of 35, those with four or more children, those who require admission on social grounds, all primigravidae, and all women with medical or obstetric abnormalities—hospital accommodation should be provided for at least 70 percent of the pregnant women in all areas throughout the country.

Norway

Dr. Julie E. Backer

The infant mortality rate for Norway has declined from 91.1 infant deaths per 1,000 live births in 1901 to 16.9 in 1963. The rate of reduction has varied considerably from period to period. For instance, the downward trend was relatively rapid in the thirties, but came almost to an end during the Second World War. During

the first decade after the War the relative decline of the infant mortality was the greatest experienced in Norway during this century. But in the middle of the 1950's this rapid downward trend was again leveling out, and lately the annual reduction ratio has been about the same as in the years just before the Second World War.

Perinatal mortality has declined 39.5 percent in the last 30 years; mortality of infants 7 to 27 days old was 70 percent lower in 1961-62 than during 1931-35; and deaths of infants 1 to 11 months were 75 percent lower. While in 1900, 38 percent of all perinatal and infant deaths occurred before delivery, during delivery, or before the end of the first week of life, in 1961-62, 75 percent of the perinatal and infant deaths occurred before the end of the first week of life.

In 1962, 80 percent of the perinatal deaths occurred before or within 24 hours after birth. This relationship has remained unchanged during this century. However, with the better obstetrical services more infants, especially premature and not viable, which in years past would have died prior to or during birth, now have been born alive and die during the first day of life.

Tuberculosis, the common infectious diseases, diarrhea, and enteritis have been practically eliminated as causes of infant deaths. Also, mortality from pneumonia and other diseases of the respiratory organs has been considerably reduced.

As infections caused by external factors have become better controlled, deaths from congenital malformations and diseases of early infancy have become increasingly prominent. While only 27 percent of all infant deaths in 1900 were caused by this group, 76 percent of the infant deaths in 1962 were caused by it.

As with England and Wales, immaturity has been the most frequently reported of the causes of early infant deaths. Not only has immaturity been linked with approximately one-third of all deaths assigned to congenital malformations and diseases of early infancy since 1930, but it has also frequently been mentioned as a subsidiary cause of death for other diagnoses. In the last 10 years, immaturity has been reported by physicians either as a primary or as a secondary cause of death for 64 percent of all infant deaths in the first month of life which were classified to dis-

eases of early infancy. Of the deaths which occurred after the first month of life 34 percent have been attributed to or linked with immaturity.

Dr. Backer indicated that, as in other countries, the illegitimate child in the first year of life has always had a greater risk of death, but the proportion of illegitimate babies in Norway has not been sufficiently high to affect the national level of infant mortality.

There is a direct relationship between the mother's age and the mortality of a baby before or during delivery. In a study of this relationship among legitimate births, it was found that the risk of a fetal death increases with the age of the mother. Among mothers aged 40-45 years the fetal death rate was 28 per 1,000 live births and fetal deaths—about three times the rate for mothers in their early twenties. In all age groups of mothers, the fetal death rate was considerably higher for first-born infants; however, during the last 20 years, the fetal death rate for first-born infants has decreased relatively more than that for children born later.

Dr. Backer attributed the great declines in Norway's infant mortality to general improvement in environmental factors, which cause infections, and in socioeconomic conditions. The increasing income of the families and the decreasing number of children per family implied better nutrition, housing, environmental and personal hygiene, in short, a more healthful standard of living. The economic progress also provided a basis for the introduction of a comprehensive system of social security and advances in public health and medical services with special bearing on the welfare of the mother and child. One indication has been the increasing number of births occurring in hospitals and maternity homes—from 75 percent in 1951 to 96 percent in 1963. As a rule, the midwife delivers the child without medical assistance, but in hospitals and clinics a doctor is always available. Therefore, in all cases where complications of labor may be expected, the mother is sent to a hospital.

Among the different legal measures which have contributed largely to the reduction of the maternal and infant mortality and morbidity in Norway are the introduction of national sickness insurance in 1911, in 1936 the provision for leave of absence from work of pregnant women before and after delivery, and in 1946 special allowance

for all breadwinners supporting more than one child.

Denmark

Professor Dyre Trolle

Denmark's infant and perinatal mortality rates have decreased by varying degrees. During the period 1921 to 1962, the fetal death rate decreased 52 percent to 11.9 per 1,000 live births and fetal deaths; the perinatal mortality decreased 44 percent to 24.9; and the total infant mortality under 1 year of age declined 74 percent to 20.0 per 1,000 live births. While late neonatal mortality of 7 days-1 month decreased 80 percent and postneonatal mortality declined 90 percent, early neonatal mortality under 7 days declined only 35 percent.

The relative declines by age have changed as follows:

Age at death	Period of decline		
	1931-40	1941-50	1951-62
	Percent		
Under 1 year--	39	44	31
Under 1 month-	15	23	16
1-11 months---	52	60	55

The smaller decline for deaths of infants under 1 month old is due to the fact that neonatal deaths are dominated by causes of death which have been subjected to limited reductions such as congenital malformations, birth injuries, and immaturity. The large decreases in mortality have been most conspicuous for infective and parasitic diseases and for diseases of the respiratory and digestive systems. There has been an excess mortality from most causes of death and in all age groups at death for males.

The number of infants born out of wedlock decreased from 1930 to the end of the 1950's; however, the number has increased since then. In 1962, 8 percent of the live-born infants were illegitimate. Illegitimate births are considered

among the high risk groups, and the excess mortality for illegitimate births in Denmark is seen for all causes except congenital malformations and hemolytic diseases.

Infant mortality in relation to parity and the mother's marital status shows increasing mortality with higher parity for infants of 2,500 grams or less of both unmarried and married mothers. For infants weighing over 2,500 grams at birth, mortality is lowest for second parity. In all cases mortality is higher for infants of unmarried mothers.

Since 1945, all women have been allowed nine free consultations during pregnancy. Three of these are with a physician at the following recommended intervals: (1) as early as possible, (2) in the 25th week, and (3) in the 34th to the 36th week of pregnancy. The other six are to be with a midwife in the 20th, 30th, 33d, 37th, 38th, and the 39th weeks. The proportion of live-born infants whose mothers take advantage of these free visits has been increasing over the last 16 years.

Delivery of infants in hospitals has been increasing in Denmark. In 1962, 46 percent of the births were delivered at home and three-quarters of these were attended by a physician. Otherwise, 10 percent of the deliveries were at private clinics, 21 percent were at general hospitals, and 23 percent were at obstetric departments.

Since 1937, when a health service law for prevention of disease and death during the first year of life was enacted, specially trained nurses, the so-called public health nurses, have been employed to supervise infants under 1 year in private homes. In 1962, there were 658 public health nurses employed, a ratio of approximately 118 live births per nurse. Although their number is increasing, there are still many rural districts with no public health nurses.

Immediately after delivery, the midwife or doctor notifies the public health nurse and shortly thereafter she pays her first visit to the home in question. In 1962, two-thirds of all infants were supervised in this way. During the infant's first year of life, the nurse pays 12 visits, most of them during the first month. At these visits, the nurse advises the mother on nursing and feeding, recommends free prophylactic medical examinations, and advises visits to a physician at symptoms of any diseases. Since 1963 she has

also routinely made examination for phenylketonuria. In addition, under an act of April 1946, each child less than 7 years old may be examined nine times free of charge by a physician, three of which are during the first year of life at the ages of 5 weeks, 5 months, and 10 months.

Netherlands

Dr. J. H. de Haas

For three reasons the Netherlands stands in a special position with respect to infant loss: (1) the rates are low compared with other countries, (2) hospitalization at birth is extremely low, and (3) infant care has a relatively long tradition. The medical demography of the Netherlands is characterized by a relatively high birth rate, low mortality rates, and a disappearance of common infectious diseases of childhood and tuberculosis.

In contrast to the experience of the United States, England and Wales, and Scotland, fetal and infant mortality rates in the Netherlands have continued to fall since 1950. Infant mortality has decreased from a rate of 51 infant deaths per 1,000 live births in 1930 to 29 in 1948, to 20 in 1956, to 15 in 1964.

Before World War II fetal mortality was on the average 50 percent higher than first-week mortality, and since 1950 about 30 percent. The position of early neonatal mortality (deaths of infants under 7 days in age) has changed relative to postnatal mortality (deaths of infants 1-51 weeks in age). In the early 1920's, postnatal mortality was three times as high as first-week mortality, and at present, first-week mortality is twice as high as postnatal mortality.

In the first week of life, birth injuries, immaturity, and congenital malformations have been the dominant causes of death. From 1953-54 to 1961-62 they decreased by 20-25 percent. Other diseases of early infancy have been fourth in importance, and have more than halved during these 8 years. During the same period total first-week mortality decreased by 25 percent.

In the postnatal period congenital malformations are the main cause of death and the rates are scarcely decreasing. The subgroup "ill-defined and other causes" occupies the second

place, and pneumonia and other respiratory diseases the third place. The rates for both of these groups are rapidly decreasing.

As medical certificates do not exist in the Netherlands, the exact distributions of birth weights and period of gestation are not available. However, independent surveys have been conducted in order to determine the extent of prematurity. In 1954 it was estimated that 5½ percent of the live births were premature. As in all other countries, prematurity is of paramount significance in perinatal mortality. During the first week of life, the risk of dying is about 20 times higher for premature infants than for infants born at term.

Infant mortality rates in the Netherlands still show the classical picture, as in Scotland and England and Wales, of a wide range by social class. In 1961-62 first-week and postnatal mortality of class I (free professions and higher officials) were 15 percent lower, and those of class V (nonfarm laborers—skilled and unskilled) were 10 percent higher than the average of the whole country.

After World War II, the Netherlands became one of the Western European so-called welfare states—social security for the great masses, little unemployment, moderate wages with increasing standard of living, no real poverty compared with prewar conditions, no serious alcoholism, and at last but not least, an average nutrition of reasonable quality and quantity. The Health Insurance Act of 1941 made health insurance compulsory under a certain level of income, giving the laborers and their families the legal right to medical care—family doctor, hospital, medicines, and so forth.

Obstetric care in the Netherlands has had three characteristics which are interrelated: (1) domiciliary confinement by general practitioners and midwives is far more usual than institutional confinement; (2) midwives give prenatal and natal care as independent practitioners; and (3) a special organization provides maternity care and help in the household for the family. By tradition, the place of delivery has been at home. In the Netherlands only 20 percent of the

live births in 1950 were delivered in a hospital; and in 1963, 30 percent of the live births occurred in hospitals. The proportion of fetal deaths delivered in hospitals amounts to about 60 percent. Perinatal mortality in home deliveries is very low—in a decade decreasing from 22 to 12 per 1,000—compared with that in hospital deliveries—decreasing in the same period from 65 to 53 per 1,000—because pathological cases are concentrated in hospitals. At present, obstetric aid is entrusted to midwives in 35 percent, to general practitioners in 45 percent, and to obstetricians in 20 percent of *all* births.

To offset low hospitalization, an organization has been founded to provide care to the mother and the newborn infant during childbirth and to temporarily manage the household duties. In 1950, this organization covered one-fourth and in 1963 half of all home deliveries. Perinatal mortality in the group with maternity-home help is half the national rate.

For the past 60 years, infant welfare centers have been set up throughout the Netherlands to give periodic examinations to infants. In 1930, there was one infant welfare center per 450 live births, while in 1960 there was one per 100. At present, the average number of examinations in the first year of life is 10 to 11.

In conclusion, Dr. de Haas stated that:

the Netherlands belongs to the privileged group of small industrialized countries with low rates of infant loss. This favorable situation was not reached because of evaluation and planning (at least not before 1950) but because of a long tradition of basic infant care in the family supplied by district nurses and welfare centers and supported by elementary social security and a rising standard of living.

The expectation is warranted that in 1970, fetal deaths will be reduced to 10-11 per 1,000, first-week mortality to 8-9 per 1,000, postnatal mortality to 3-4 per 1,000, perinatal mortality to 18-20 per 1,000, and infant mortality to 11-13 per 1,000.

INFANT MORTALITY PROBLEMS IN THE UNITED STATES

Mr. Sam Shapiro

Mr. Shapiro opened with a brief background of the 1950 demographic and socioeconomic picture in the United States. He pointed out that the leveling off of the infant mortality rate in the United States came earlier than it did in most of the other countries with which comparisons were being made. Furthermore, in more recent years the leveling off has resulted in higher neonatal and postneonatal mortality rates in the United States than in most of these other countries.

The United States has always had a comparatively low fetal mortality rate; however, the rate of decline appears to have slowed down more than for other countries. The perinatal mortality rate (fetal deaths of 28 weeks' and over gestation and deaths of infants under 1 week old) maintained a comparatively middle position in the postwar period. Currently it is one of the highest among the countries under discussion.

Mr. Shapiro next turned to discuss the issue of risk factors and what has been happening in the United States in relation to them. The male-female differential in infant mortality has changed very little over the past 25 years. At the present time, there is an excess of 30 percent in the mortality among male births.

It is apparent that the rate of decline for both the white and nonwhite populations decreased during the 1950 decade. Although the overall picture that is found for white and nonwhite persons combined is reflected in the situation for the white, the decrease in the rate of decline was more serious in the nonwhite population. During the 1950's and 1960's the differentials increased so that in 1962 the rate for nonwhite infants was about 85 percent higher than that for white infants.

During the 1950 decade, infant mortality decreased more rapidly in the nonmetropolitan areas than in the metropolitan areas, and today there is only about an 11 percent differential between their rates. It is believed that about 50 years ago urban areas had a higher infant mortality rate than did rural areas. Subsequently,

there was a crossing over with urban areas having a lower rate. In the early fifties the urban areas again had infant mortality rates slightly higher than those of the rural areas. Interestingly though, this reversal or converging of the urban-rural infant mortality rates in recent years is due entirely to what has been happening to the white population; the nonwhite infant mortality rate has remained lower in urban areas than in rural areas.

The situation in large cities has drawn considerable attention. The infant mortality rate in many of the large cities has remained unchanged in the white population, and has increased in the nonwhite population. Part of the speculation about this phenomenon is that there has been a migration among white persons from these large cities into the surrounding urbanized areas with an important social class selectivity factor operating. There, the speculation is that as the higher social class is moving away from the central city into the suburban area, a more adverse risk group of the white population has remained in the cities. In the nonwhite population the phenomenon has been different. There has been a migration into the cities and hence a very substantial increase of the nonwhite population in many of the cities.

Prior pregnancy history is another risk factor involved in the outcome of the current pregnancy. If a mother has a prior fetal loss in her background, there appears to be at least a doubling in the risk of a fetal death in the current pregnancy. There is also an elevated risk of a premature birth among women who previously have had a prematurely born infant.

This introduces the factor of birth weight. In the United States in 1950, the first year for which there are national data, 7.5 percent of the live births weighed 2,500 grams or less—7.2 percent of white and 10.4 percent of nonwhite births. The proportion of births at low birth weights has increased to 8.2 percent (1963) due almost entirely to a sharp increase in the rate among the nonwhite population.

There is a fairly clear indication from data for Upstate New York that the neonatal mortality rate, from the late 1940's to the early 1950's, decreased among both babies weighing 2,500 grams or less and those weighing

over 2,500 grams at birth; however, there has been no decrease in the neonatal mortality rate among the low-birth-weight infants since then.

It is generally accepted that socioeconomic class is a very important discriminating factor in infant mortality. However, there are no data available for the United States as a whole on this issue. Dr. Helen C. Chase has reported on the experience in New York State (excluding New York City) for 1950-52. One point of interest relates to the comparatively modest variations in perinatal mortality (defined as infant deaths under 28 days of age and fetal deaths of 20 weeks' or more gestation) by social class based on the father's occupation. A one-third gradient in the loss rate was found between the professional category and the laborer category (nonagricultural).

There are many difficulties in drawing inferences from cause-of-death information because of the great variation that may exist among countries in the way cause of death is assigned. Nevertheless, from the standpoint of international comparisons it would appear that the United States cannot single out any one or two particular causes of death to which to attribute the differentials in either neonatal or postneonatal mortality. The United States seems to have an elevated infant mortality in the great majority of the causes of death.

The final point made was that very recent events indicate that the infant mortality rate in the United States is still declining very slowly. However, no segment of the population is experiencing a large-scale reduction in the rate.

Discussion

The discussion that followed Mr. Shapiro's report centered on the problem of social class differentials. It was pointed out that data from New York State, exclusive of New York City, of mortality differentials by social class, as defined by the father's occupation, became more apparent in the postneonatal and early childhood periods. The chance of a low-birth-weight baby being born dead or of dying within the first month of life was shown to be the same for all occupational groups, but the chance of the low-

birth-weight baby surviving later was quite marked by social class. Professor Trolle remarked that in Denmark, on the other hand, social class differences were seen both in the occurrence of low-birth-weight babies and in their neonatal mortality.

The fact that social class is indeed a difficult factor to analyze was emphasized. Problems of family disorganization, medical status before pregnancy, and the nature of prenatal care all contribute to make this a highly complex situation. Mr. Shapiro suggested that this view was supported by data from a study of births in New York City in 1955. In this study, births were classified by whether the mother was hospitalized as a general service ward patient or as a private patient. The results showed that nonwhite patients of private physicians had a perinatal loss which was very similar to the loss among white patients admitted to the general service ward. This would seem to indicate that a simple dichotomy between private care and general service ward care, or, for that matter, any single measure of social class will not entirely explain the situation.

DIFFERENTIAL FACTORS IN INFANT MORTALITY

Statistical Artifacts

Dr. Bernard G. Greenberg

Dr. Greenberg led the discussion on statistical artifacts which might possibly affect international comparisons of infant mortality. He concentrated on three possible artifacts: (1) definitions and requirements for reporting, (2) registration and notification practices, and (3) coding and tabulating practices. Dr. Greenberg also summarized the significance of various demographic factors in relationship to international comparisons of infant mortality.

For all practical purposes, live births and fetal deaths are *defined* alike in the United States and in the Western European countries under discussion. However, requirements for reporting fetal deaths vary according to the period of ges-

tation for which registration and/or notification is stipulated by law. The participating foreign countries require that all fetal deaths after the 28th week of gestation be reported. In the United States, each State determines its own laws for registration of vital events. Most of the States use the minimum gestation period equal to or greater than 20 weeks; one State, Pennsylvania, requires that fetal deaths greater than 16 weeks' gestation be registered, and nine States and New York City require that fetal deaths of all periods of gestation be registered.

The variation in registration requirements may be responsible in part for the variation in the fetal death ratios. The gestation period at which reporting is required will affect not only the total number of fetal deaths, but also the distribution of fetal deaths by gestation periods above the minimum level required. Dr. Greenberg showed that in certain States of the United States registration at 20-27 weeks' gestation was increased when the minimum period was lowered.

For example, within the past 13 years, 10 States changed their registration requirements so that the minimum gestation period for which fetal deaths must be registered was lowered. In one case, South Dakota, this requirement was changed back to its former level in 1959. Table 1 shows the year the change was effected and indicates the change. Analysis of differences in the distributions of fetal deaths of 20 weeks' gestation or more showed that after the registration change the proportion of reported fetal deaths of 20-27 weeks' gestation increased in each State. The overall weighted average ratio for the 20-27 week interval increased from 21.2 to 29.3 (an arithmetic change of 8.1 as shown in table 2).

In order to determine whether this trend occurred in other States where no change was made in the minimal period for which a fetal death must be reported, Dr. Greenberg looked at the trend for Upstate New York. Here the requirements for registration remained at 20 weeks or more. Data for the years 1950-56 were compared

Table 1. Change in period of gestation for which fetal death registration is required: 10 States of the United States, 1950-63

Area	Year of change	Change in minimum gestation period required for registration	
		From	To
Arkansas-----	1960	Although defined for all periods of gestation, reporting limited to 20 weeks' gestation or more	All periods of gestation
Colorado-----	1954	20 weeks' gestation or more	All products of conception
Georgia-----	1954	20 weeks' gestation or more	All products of conception
Hawaii-----	1960	No specified gestation	All periods of gestation
Maine-----	1955	20 weeks' gestation or more	All products of conception
Mississippi----	1952	20 weeks' gestation or more	All products of conception
Oregon-----	1952 ¹	20 weeks' gestation or more	All products of conception
Pennsylvania---	1954	20 weeks' gestation or more	16 weeks' gestation or more
South Dakota---	1953 1959 ¹	20 weeks' gestation or more All products of conception	All products of conception 20 weeks' gestation or more
Virginia-----	1960 ¹	20 weeks' gestation or more	All products of conception

¹Changed requirement July 1; all other States changed requirement January 1.

Table 2. Change in ratio of fetal deaths by week of gestation to all fetal deaths 20 weeks and over, and the relative change in reporting, when minimum period of gestation required for registration was lowered: 10 States of the United States, 1950-63

Area	Years prior to change	Years after change	Arithmetic change in ratio by week of gestation							Relative change in reporting of fetal deaths ≥ 20 weeks ¹
			20-27 weeks	28-35 weeks	≥ 36 weeks	36 weeks	37-39 weeks	40 weeks	≥ 41 weeks	
Arkansas-----	1956-59	1960-63	+4.9	+0.1	-5.0	-1.1	-0.1	-3.2	-0.6	1.1649
Colorado-----	1950-53	1954-63	+13.3	-4.3	-9.0	+8.2	+9.5	-30.2	+3.5	1.0344
Georgia-----	1950-53	1954-63	+10.5	-7.1	-3.4	+9.0	+4.6	-18.3	+1.4	1.0469
Hawaii-----	1952-59	1960-63	+3.0	+2.6	-5.5	+1.5	+2.6	-9.4	-0.1	1.0381
Maine-----	1950-54	1955-63	+3.6	-0.7	-2.9	-0.5	+0.1	-3.4	+0.1	0.8758
Mississippi-----	1950-51	1952-63	+8.3	-0.7	-7.6	-0.4	+0.6	-7.7	-0.1	1.0311
Oregon ² -----	1950-51	1953-63	+11.2	-7.8	-3.3	-0.8	+3.1	-7.2	+1.6	1.1657
Pennsylvania----	1950-53	1954-63	+5.8	-1.5	-4.3	-2.2	+1.3	-4.1	+0.8	1.0370
South Dakota ^{2,3} ---	1950-52 1960-63	1953-58	+7.3	-1.5	-5.8	-1.7	+0.6	-3.7	-1.1	1.0371
Virginia ² -----	1950-59	1961-63	+10.2	-0.8	-9.4	-2.5	+0.4	-7.5	-0.2	1.0472
Weighted average	+8.1	-2.5	-5.6	+0.7	+2.1	-9.1	+0.8	1.0435

¹Relative change = $\frac{\text{Observed fetal deaths after change}}{\text{Expected fetal deaths after change}}$, where expected fetal deaths after change = (adjustment factor for decline in fetal death ratio) x (observed fetal death ratio before change) x (live births after change).

²Changed requirement July 1; all other States changed requirement January 1.

³Data for the periods 1950-52 and 1959-63 were combined because registration requirements were the same. The minimal registration requirement was lowered only for the period 1953-58 (table 1).

with those of 1957-63, and the following arithmetic changes in the proportion of fetal deaths by gestation period were found:

Period of gestation	Change in ratio
20-27 weeks-----	+1.6
28-35 weeks-----	-0.5
36 weeks and over-----	-1.1
36 weeks-----	-0.5
37-39 weeks-----	+1.5
40 weeks-----	-2.0
41 weeks and over-----	-0.2

These changes seem trivial compared with those for States that lowered their registration requirements. It would seem then, that the change in the distribution of fetal deaths of 20 weeks or more that occurred after registration requirements lowered the minimum gestation period is real and not merely a function of time.

However, a second question arises. Did the increase in the interval 20-27 weeks result from cases that were formerly unreported or was it a shifting of fetal deaths within the total group from one gestation interval to another? To check this, Dr. Greenberg looked at Upstate New York again and computed how much the fetal death ratio had changed during this 14-year period. He found that it decreased about 10 percent in the 7

years from the midpoint of 1950-56 to the midpoint of 1957-63. This was the same rate of decline observed in the total fetal death ratio for the United States. In order to adjust the decline in the fetal death ratios of the other States so that a true assessment of the change could be made, Dr. Greenberg assumed that the period after the registration change should have a fetal death ratio lower than that prior to the change at a rate of about 10 percent for every 7 years. This gave him an expected fetal death ratio which, when multiplied by the live births after the change, resulted in the expected number of fetal deaths.

Next, he computed a relative increase based upon the observed fetal deaths during the period after the change over the expected fetal deaths. Increases in the ratio of observed to expected fetal deaths would indicate a real change in the total number of fetal deaths reported at 20 weeks or more. Table 2 shows the relative changes. Nine of the States increased, some as little as 3 percent, and two as much as 16 percent.

Dr. Greenberg concluded that if the European nations were to lower the minimum reporting period to less than 28 weeks, the total number of fetal deaths would probably increase by as much as 4.35 percent. Since the United States registers fetal deaths of 20 weeks or more, any comparison of fetal deaths 28 weeks and over with the European countries would be biased *against* the United States. When the fetal deaths of 28 weeks and more are examined in order to compare the United States with some of the European nations, the fact that the United States has a lower reporting period influences the fetal death ratios.

A second source of variation in the fetal death ratio arises from differences in determining the period of gestation. Four registration areas in the United States base gestation upon the specified date of last menses, while other areas base it on the weeks of gestation as reported. When New York City changed its method of recording gestation in 1957 and requested that the data of the first day of the last menstrual period (LMP) be reported, so that the length of gestation could be more accurately and consistently calculated, the fetal death ratio at 20 weeks' or more gestation increased 24 percent. At the same time,

however, the proportion of "not stated" gestation periods increased. Discussion brought out the question of whether other factors added to this sharp increase, such as the concentrated campaign for better registration which was being conducted by New York City. However, it was resolved that this study was concerned with the immediate effect of the change in reporting the age of the fetus at a time when the influence of the campaign for complete registration was waning. The point to be further studied is that if data for the United States—New York City to be specific—can be increased by as much as one-fourth because of a change in the method of reporting period of gestation, then how is gestation period determined in foreign countries and how does the measurement compare with that of the United States?

Dr. Greenberg next discussed tabulation procedures. In the United States, England and Wales, Scotland, and Norway, first-day mortality includes deaths within 24 hours after birth. However, in Denmark and the Netherlands, first-day mortality includes only deaths occurring on the calendar day of birth. In order to appraise the effect of this tabulation difference, Dr. Greenberg calculated a separation factor from the distributions of (1) births by hour of birth for a 24-hour period, and (2) deaths by hour of death among those infants dying within the first 24 hours after birth. This separation factor was simply the percent of babies which die within 24 hours after birth and which do not die on the same calendar day of birth. Based on 108,000 live births in Indiana in 1957 and on the assumption, verified by North Carolina data, that the distribution of first-day deaths approximately follows a simple exponential curve, he estimated the separation factor to be approximately 22 percent. Otherwise stated, deaths within 24 hours after birth exceed deaths occurring on the same calendar day of birth by about 28 percent.

However, from Norwegian data of 1949-51 and 1959-61 deaths were tabulated for the periods of 24 hours after birth and for the same calendar day of birth. The two groups of data indicated that 28.5 percent of the deaths within the first 24 hours of life did not occur on the same calendar day of birth. As a compromise,

Dr. Greenberg felt that the mortality rates of death under 24 hours should be reduced by 25 percent before comparison with data in the Netherlands and Denmark for first-day mortality. Conversely, deaths under 1 calendar day for the Netherlands and Denmark should be increased by $33\frac{1}{3}$ percent so that the data for first-day mortality would be more comparable to the United States, England and Wales, Norway, and Scotland.

If first-day mortality is increased in certain countries, then deaths tabulated as 1-6 days of age must be decreased correspondingly.

The general conclusion at this point was that these statistical artifacts were not sufficiently large to account for all the differences in first-day and first-week mortality between the United States and the European nations under investigation here.

Next, Dr. Greenberg summarized the incidence and significance of demographic factors such as age of mother, birth order, and birth weight which were discussed by Dr. van den Berg in a paper distributed at the conference. He concluded, in concurrence with Dr. van den Berg, that although the distributions of live births by the mother's age and by birth order are not favorable in the United States compared with those in the Western European countries, they do not account for the total differences in the neonatal mortality rates.

Emphasis was placed on the significantly higher incidence of low-birth-weight babies in the United States. While the United States had 8.2 percent live births of 2,500 grams or less in 1963, England and Wales had 6.6 percent. The

Netherlands estimated about 5.5 percent in a special survey in 1954; and Norway currently estimates about 5-6 percent. Even though neonatal mortality of these low-birth-weight babies may be essentially the same for the various countries, the fact that the United States appears to have a greater proportion of these births has a significant effect on its neonatal mortality rate. A look at registration practices and other factors such as sex ratio, plurality of birth, illegitimacy, age of mother, and birth order indicated that they do not seem to account for the observed international differences in the incidence of low-birth-weight infants.

Dr. Greenberg continued the discussion of low birth weight by considering whether the high incidence of small babies in the United States was genetic or cultural. He looked at the data for two States with high proportions of people of Scandinavian background. Within the two States, Minnesota and North Dakota, he compared the proportion of low-birth-weight babies in the counties with the highest percentage of Scandinavians to that of counties with the lowest percentage as determined by 1960 Census data. In Minnesota, the Scandinavian background was defined to include Norwegian, Swedish, and Danish stock. In North Dakota it included Norwegian and Swedish backgrounds only. In order to obtain meaningful data, Dr. Greenberg combined data for the years 1955-59. The data showed that the counties with the highest percentage of Scandinavian stock had a lower proportion of births of 2,500 grams or less than did the counties with the lowest proportion of Scandinavian stock (table 3).

Table 3. Percent of live births of 2,500 grams or less: Minnesota and North Dakota, 1955-59

Place	Minnesota	North Dakota
Entire State-----	5.7	6.3
Counties with highest proportion of Scandinavian stock-----	5.1	6.0
Counties with lowest proportion of Scandinavian stock-----	5.6	6.4
Entire State minus counties with highest proportion of Scandinavian stock-----	5.8	6.3

Although these data are not conclusive, they do present an interesting point for further investigation.

Discussion

Discussion concentrated on the problems of definition and underregistration. Although the definition of live birth officially appears to be the same for the United States and the other countries involved in the comparison, registration practices do seem to differ. For example, Denmark, and until recently, England and Wales used only the criterion of breathing to determine a live birth, while other countries used the criterion of any signs of life, such as, breathing, pulsation of umbilical cord, heart beat, movement of voluntary muscles, and so forth.

Based on discussion of underregistration in the United States and in the Western European countries, it was concluded that some underregistration and undernotification do indeed exist, but the extent to which they exist has never been exactly determined. Dr. de Haas estimated underregistration in the Netherlands to be about 10 percent, but the other European countries felt that their registration was fairly complete. The discussion ended here with the general impression that more study was needed.

Socioeconomic Factors

*Dr. Barbara J. van den Berg and
Dr. Arthur J. Lesser*

Dr. van den Berg summarized the data available on social class differentials, referring to studies in the United States which showed a higher percentage of low-birth-weight babies among the less favorable socioeconomic classes, and hence a higher neonatal mortality rate in these lower social classes. She stated that in the United States a greater part of the population is more "severely handicapped by unfavorable conditions than are the people in the Scandinavian

countries and some of the Western European countries." The indications cited were:

unemployment, education, illiteracy, and housing conditions . . . Unfavorable economic conditions of families in the United States are intensified by the fact that medical care is not as freely available to them as it is in some of the European countries and no maternity allowances are given to cover the extra financial burden of a delivery and no maternity benefits are given to working pregnant women.

Dr. Lesser emphasized the need for better medical care facilities for the low-income families. Recognizing the fact that there is a positive association between family income and infant mortality, Dr. Lesser described the worsening situation within cities over 500,000 population in the United States. As there has been an influx of lower income and higher infant mortality risk groups to the large cities, there has been a corresponding increase in the number of people who are dependent upon tax supported medical services. Compounding the problem is the fact that this same group seeks prenatal care late in pregnancy or not at all, and at the same time this is the group with an excessive rate of low-birth-weight babies.

Together with these worsening social factors is the increasing cost of hospital care, with a decrease in the ability of voluntary hospitals to provide free prenatal and hospital delivery care. The result has been an increase in the number of deliveries in tax-supported hospitals without an increase in hospital capacity. These hospitals have become overcrowded and the length of stay at the time of delivery in a hospital has been shortened. Discussion brought out that a new maternity and infant care program with an appropriation this year of \$15 million from Federal funds has been started to respond to these needs. Also, there have been an increasing number of maternal-child-health clinics. In order to remedy the decreasing number of personnel available for obstetric care, several programs for training nurses in midwifery have been initiated.

In conclusion, it was mentioned that although it is recognized that many infant deaths

occur in the low socioeconomic groups, the extent to which these deaths affect the total infant mortality rate is not known. Further study is needed here.

Medical Factors

Dr. William A. Silverman

Dr. Silverman opened the discussion on medical factors associated with the differential infant mortality by raising a series of pertinent and provocative questions. First, he questioned the adequacy of birth weight as a measure of survival. As a single criterion it tends to obscure the fact that fetal growth is influenced by many factors, such as fetal malnutrition or fetal infections. Hence, low-birth-weight babies have different chances of survival. It would be important to obtain good standards of fetal growth so that aberrations could be confidently identified at birth.

In response to this comment, Dr. Yerushalmy discussed his study in which a 5-point classification system of both birth weight and gestation age as an index of fetal maturity was devised (table 4). The study showed that in both neonatal and postneonatal periods mortality increased from group 5 to group 1; however, the gradient was more pronounced in the neonatal deaths. In the low-birth-weight group (3½-5½ pounds), infants with the shorter gestation period experienced a higher mortality risk, while those with the longer gestation period had a greater risk of being congenitally malformed.

Lengthy discussion followed pointing out the various problems with the criteria of birth weight and gestation age, partially in response to Dr. Silverman's question of whether there truly were differences in the rate of fetal growth in different ethnic groups. Points made were that the median birth weight does vary for different groups and this consequently would affect the point at which a baby is considered low in birth weight. Optimum birth size (the birth size at which both the baby and the mother have the greatest chance of survival) varies. For example, in the United States the optimum size for a white birth is between 3,500-4,000 grams, whereas it is 500 grams less for a nonwhite infant.

The general conclusion reached at this conference, however, was that, in spite of these problems, birth weight is certainly the more important criterion. However, as we are not dealing with a uniform population when considering intact survival, additional measurements must be considered. It was at this point that Dr. Silverman urged that the first day of last menstrual period be used actively as a more accurate and consistent measure of gestation age.

Dr. Silverman's next series of questions revolved around the problem of mechanisms which are responsible for major perinatal disorders of uncertain etiology. Is the incidence of hyaline membrane disease indeed lower in the Scandinavian countries than in the United States? Is there an indicator, such as socioeconomic differences, which could be used to predict the premature rupture of membranes in various populations? How much is the distribution of causes affected

Table 4. Index of fetal maturity

Group	Description	
	Birth weight	Period of gestation
1	3 lbs. 8 oz. or less	All gestation periods
2	3 lbs. 9 oz. - 5 lb. 8 oz.	Under 37 weeks
3	3 lbs. 9 oz. - 5 lb. 8 oz.	37 weeks or more
4	5 lbs. 9 oz. or more	Under 37 weeks
5	5 lbs. 9 oz. or more	37 weeks or more

by the relativity of the diagnoses within the various countries?

These questions led to a discussion of the growing problem of the etiology of mechanical suffocation, or the so-called crib death. Several theories of the true nature of these deaths were discussed; however, no agreement was reached about the etiology.

Dr. Silverman next turned to look at the issue of national differences in medical practices. To what extent are these practices related to pregnancy outcome and what changes in practices have occurred during the period under study? For example, during one recent period in the United States there was a change in the practice of the administration of oxygen to low-birth-weight infants, and as a result the incidence of retrolental fibroplasia decreased when oxygen was given sparingly. What has been happening in the foreign countries? How is pregnancy outcome affected by the use of drugs and other medical methods used to induce labor? How is the severely involved fetus identified? In short, there have been marked changes in the policy of fetal care and delivery over the past decades. How have these changes affected infant mortality, and how do they compare internationally?

Dr. Silverman's questions stimulated others in response. In reaction to the comment that the United States is aggressively using active resuscitation, it was surmised that possibly resuscitation of the newborn infant was used more often where the use of anesthetics and analgesia was more common. On the other hand, the advisability of such active intervention was questioned.

Another point raised was whether abortion acted as a means of preventing some infant deaths. The Netherlands and Denmark felt that the number of abortions in a year would not affect their total infant mortality rate. However, there is no way to tell now. In order to answer this question there would have to be a study of the risk factors related to women having abortions.

These questions were raised not only as an impetus to spur on discussion, but also as a means to point out the real difficulty in comparing international medical practices in connection with infant mortality. They indicate that additional work is needed to understand basic practices before international comparisons can be reliable and meaningful.

Dr. William J. Schull of the University of Michigan Medical School took time during this discussion to cite some of his work showing the effects of heredity on mortality. He stated, in agreement with Dr. Moriyama, that there is indeed an irreducible, *nonzero* minimum in infant mortality. One reason is that there will always be in every culture what may be termed the *iatrogenic death*. "Every culture, regardless of how primitive it has been or how sophisticated it may become, will have to pay a price for the administrations of its medicine men." Secondly, a substantial body of biological evidence shows that a significant portion of infant deaths is of genetic origin.

Ultimately, the chances of survival in a population are limited by its genetic load—"the price that any population, human or otherwise, pays for maintaining genetic variability"—and this load may differ from nation to nation. Dr. Schull showed how the "concealed load," the genetic burden of a population apparent upon inbreeding, can affect the shape of a population. The principal source of information on the "concealed load" stems from studies among the children of parents biologically related to one another. Such studies in Japan in 1956 and 1958-60 showed that increased inbreeding had as a result (1) smaller babies, (2) increased infant mortality, but (3) less childlessness.

Dr. Schull also reported that in Hiroshima and Nagasaki socioeconomic status was lower as a function of inbreeding. He reported that school performance of children diminished with inbreeding; that is to say, the child of biologically related parents was a poorer performer in all aspects of school work. Here, Dr. Schull pointed out that possibly the parents of these children were of a lower socioeconomic status because they were inherently poorer illustrations of the genetic potential of Japan. This may tie in with the socioeconomic differentials in infant mortality reported by Great Britain.

Finally, Dr. Schull observed that animal studies suggest that child survival is apt to be a function not only of the child's own genetic constitution, but also of the genetic constitution of his mother. This was seen in studies with cattle and swine where mortality increased with inbreeding in the offspring and inbreeding in the mother, regardless of the father's background.

SUGGESTIONS FOR FURTHER STUDY

No clear-cut explanations of the significant international differences in infant mortality emerged from the discussions of the conference. It was generally agreed that the international mortality differentials could not be attributed to a particular statistical artifact or difference in demographic distributions. However, it could not be said with any certainty that the cumulative effects of all these factors would not account for the difference in mortality.

Although mention was made throughout the course of the conference of the need for further study into the various aspects of the infant mortality problem, provision was made in the program for a specific discussion of needed research on problems of infant mortality. Suggestions for further study fall under the following general headings: (1) basic problems of definitions; (2) registration practices; (3) determinants of perinatal and infant mortality; and (4) medical factors related to perinatal and infant mortality.

Definitions and Registration Practices

Definitions of live birth and fetal death.—All of the countries involved in the discussion have adopted the definitions of live birth and fetal death recommended by the World Health Organization. An integral part of these definitions is the criteria of life, namely, breathing or other evidence of life such as beating of the heart, pulsation of umbilical cord, or definite movement of voluntary muscles. If a child breathes or shows any other evidence of life after complete expulsion or extraction from its mother, even though it be only momentary, it is required that the event be registered as a live birth and also as an infant death. This registration requirement is a change from that of the past in Sweden, for example, when breathing was the only criterion for determining whether an event should be registered as a fetal death or live birth.

Although no information is available, it is possible that some small immature infants born alive are registered as fetal deaths rather than as a live birth and infant death. These events would not have any significant effect on the live birth totals, but could have a marked influence on the

fetal death rate or the infant mortality rate. For accurate international comparisons, it is important to determine how precisely the criteria of life are being applied by the attendant at birth in the registration of live birth and fetal death.

Two approaches were suggested in the study of this problem. One method was to follow back on a sample of birth records with a questionnaire or an interview and obtain from the attendant at birth information on the criteria which were used in determining whether a specific event was a live birth or a fetal death. The other proposal was to review hospital records in order to determine the criteria that were applied. The proportion of deliveries occurring in institutions would be one of the controlling factors in the choice of methods.

Registration completeness.—There is very little quantitative information available on registration completeness. The last test of birth registration completeness in the United States was made in 1950, and showed that 2.1 percent of the live births were not registered.

There have been *no* national tests of completeness of death registration for the United States or for other countries. However, there have been several local studies in the United States from which estimates of underregistration have been made. Using data from records of the Emergency Maternity and Infant Care Program in New York City (1943-45), Baumgartner et al. found that 14 percent of the fetal deaths occurring in the third trimester of pregnancy were not registered.³ Schlesinger et al. estimated that in Onondaga County, New York (1951-52) about 7 percent of the fetal deaths of 28 weeks' or more gestation were underregistered; however, these particular data were records from hospitals in an urbanized county where physicians and hospitals should be more aware of reporting requirements.⁴ The total United States would probably show a higher proportion of underregistered fetal deaths, since these studies used limited samples. Nevertheless, these are rather high estimates of underregistration and indicate that national study is needed.

³Baumgartner, L., Wallace, H. M., Landsberg, E., and Pessin, V.: The inadequacy of routine reporting of fetal deaths. *Am. J. Pub. Health.* 39:1549-1552, Dec. 1949.

⁴Schlesinger, E. R., Beecroft, R. K., Silverman, H. F., and Allaway, N. C.: Fetal and early neonatal deaths in Onondaga county, New York. *Pub. Health Rep.* 74:1117-1122, Dec. 1959.

As more attention is shifted from infant mortality to perinatal mortality, the problem of fetal death underregistration becomes increasingly important. Incomplete reporting of fetal deaths makes accurate assessment of pregnancy wastage difficult, and hampers investigation of the risk factors influencing perinatal mortality.

Precise regional or international comparison of fetal and perinatal death rates is also impaired. For instance, the United States shows a late fetal death rate lower than any of the Western European countries. In 1962, the fetal death rates for the Scandinavian countries and the Netherlands were approximately 15 percent higher than the rate for the United States. The rate for Great Britain was about 50 percent higher. Part of these differences can be attributed to incomplete registration; however, the extent to which this is so needs to be determined.

One recommended method of study into the problem of underregistration was to follow a cohort of recently married couples to the termination of the first pregnancy, in order to determine *if* and *how* the event was registered. Another possibility is to establish some kind of pregnancy roster from information from maternity clinics, and to follow the individuals on the roster through to the termination of the first pregnancy. It was suggested that if international comparisons were to be made, an international sample should be selected, and standard forms and protocols be used.

Determinants of Infant Mortality

Birth weight.—The incidence of low-birth-weight infants remains largely unknown in countries outside the United States. However, from special surveys conducted in England and Wales, the Netherlands, and Norway the estimates seem to indicate that the United States has a higher incidence of low-birth-weight babies. Furthermore, in the United States the proportion has been slowly increasing since 1950.

Low-birth-weight infants have a much greater chance of dying, and hence contribute significantly to neonatal mortality. Yet, there has been no nationwide examination of this problem since 1950. In view of the retardation in the rate of

decline in the infant mortality rate, there is a real need to obtain national data on the relationship between birth weight and infant mortality. It was suggested that one type of study be made by matching infant death certificates to their respective birth records. From the birth certificate can be obtained baseline information such as birth weight. A study of this type was launched in 1960 in the United States; however, the results of this study are not yet available.

For purposes of international comparisons, additional efforts would have to be made since birth weight does not routinely appear on the certificates of the foreign countries represented at this conference, except Denmark, which only recently added birth weight to its statistical records. Other sources were suggested from which data could be drawn for comparison with vital event records. In areas where prenatal care records exist in sufficient accuracy and completeness, they could be matched to birth, fetal death, and infant death certificates. Hospital records could be used in countries where a large proportion of deliveries occur in hospitals; and in instances where midwives attend most of the deliveries, their records would be a source of basic information.

Socioeconomic status.—The investigators in Great Britain have studied the relationship between socioeconomic class and infant mortality. Socioeconomic class, as determined by the occupation of the infant's father, has evidently had a significant effect on the newborn infant's prospects of survival. They have found that lower infant mortality rates occur in the higher classes and that there is a large gap between the highest and lowest class. Moreover, the gap has been widening.

It has been noted in the United States and in England and Wales that the proportion of low-birth-weight infants is higher in the lower socioeconomic classes. The question arises whether this higher proportion is responsible for the higher infant mortality rate in the lower socioeconomic classes. Or, is socioeconomic status a factor more important for determining the level of infant mortality? What are the problems associated with low-birth-weight (and premature) neonates born to women in the lower social classes?

In considering the socioeconomic situation, the problem of adequate measures by which to define a socioeconomic class was raised. Since the mother's background has an important effect on her reproductive capacity, is the occupation of the infant's father a sufficient measure of social class? Which aspects of social class have an important relationship to pregnancy outcome?

Except for local studies in New York State and California, little recent information has been collected on the relationship of infant mortality and social class. More information is needed on this subject in the United States.

Ethnic background.—During the conference there was discussion of the relationship of ethnic background to pregnancy outcome. It was shown in a preliminary investigation that in Minnesota and North Dakota ethnic background may have an effect on the incidence of low-birth-weight infants. It has also been indicated that Oriental infants have lower mortality rates than do white infants in the United States. However, further study is needed to determine more exactly the relationship between infant mortality and ethnic origin. For instance, how do the infant mortality rates of different ethnic groups compare by socioeconomic class? What effect does ethnic background have on the size of the infant at birth? What influences do immigrant groups have on the total infant mortality rate?

Medical Factors Related to Infant Mortality

Medical care.—There are important differences in the provision of prenatal and natal care in the various countries; however, no evidence was presented to suggest that the level of obstetrical and pediatric care *per se* accounts for a large part of the international differences in infant mortality. The effects of prenatal, natal, and neonatal care are important to the study of infant mortality, yet little is known about them. It was suggested that the relationship of prenatal and obstetric care, including the use of anesthesia, drugs, and hormones, to pregnancy outcome be examined. For instance, how are complicated pregnancies treated, and how does the treatment relate to the outcome?

Several factors connected with the medical care of the mother and infant before and after birth were mentioned as important for study. For

example, women in the lower socioeconomic strata are less apt to secure early prenatal care, and at the same time are more likely to experience poor pregnancy outcome. A study of mothers, integrating information on socioeconomic class level during their early life as well as at the time of delivery, and details of prenatal care would be important to the study of factors correlated with infant mortality.

The incidence of congenital malformations related to prenatal factors such as drugs taken during pregnancy and maternal infections could be inspected in countries with high proportions of hospital deliveries. Such a study would involve the integration of prenatal, hospital, and pediatric records.

The question was raised during discussion about benefits to be derived from large-scale resuscitation of the newborn infant. What is the relationship of active resuscitation of the neonate to his well-being? This type of investigation could best be conducted in the hospital setting.

In the United States the average hospital stay at the time of delivery is about 4 days; whereas in Scotland it is about 9 days, 10 days in England and Wales, and 11-12 days in the Netherlands. However, the effect of hospital stay on the neonate is unknown. Study of the relationship of postnatal hospital stay to neonatal mortality could be conducted by combining birth, hospital, and death information.

Diseases peculiar to early infancy.—The neonatal death rate has been leveling off during the past decade in the United States, yet this change has not been occurring to the same extent in the European countries. Mortality rates for the major causes of neonatal death have been declining; however, the death rate for diseases peculiar to early infancy has been increasing in the United States and England and Wales, while decreasing in the Western European countries. Part of this increase appears to be from the increased reporting of hyaline membrane disease and respiratory distress syndrome. It was suggested that a detailed investigation of these diseases be made in order to determine the meaning of this upward trend.

Incidence of infections.—The postneonatal mortality rates for many countries have been cut approximately in half since 1950. However, the postneonatal mortality rate for the United States

has declined very slowly and is now at a relatively high level compared with the rates for other countries of low mortality.

In 1959-61 over 43 percent of the postneonatal deaths in the United States were attributed to infectious diseases. Further reductions in mortality from this cause are still possible; however, study of the epidemiological and medical aspects of infections is urged in order to determine the underlying factors of these diseases.

Major disorders of uncertain etiology.—Concern over the increasing frequency of major disorders of uncertain etiology prompted proposal for thorough study of the incidence of sudden and unexpected deaths, and mechanical suffocation in bed or cradle with or without reference to the certifying physician. What mechanisms are responsible for these disorders?

In 1963 there were 2,998 accidental deaths among the infants between 28 days and 1 year of age in the United States. Of these, over 25 percent were ascribed to suffocation in bed or cradle. These deaths have been under question as there is evidence that most of these deaths are not due to accidental mechanical suffocation, but are a result of some fulminating infection or allergic reaction. A study needs to be made which would include pathological evaluation of the validity of the clinical diagnosis.

In recent years, attention has been called to the sudden and unexpected deaths. Some of these deaths appear to be due to respiratory infections. Epidemiological investigations could be made of these deaths with special attention to infections among them.

Incidence of nonfatal handicapping conditions.—Improved fetal and infant survival may result in an increase in infants with handicapping neurosensory conditions. It was proposed that examination of this possibility be made. A study of this relationship would require cooperative investigations by a number of hospitals with followup pediatric and psychological examinations.

SUMMARY

In an effort to explain the infant mortality situation in the United States, a significant number of problem areas in the study of infant and perinatal mortality were brought into focus at

this 2-day conference. Among the areas considered were the problems in the interpretation of international data arising from variations in definitions and in registration and statistical practices. Risk factors, such as the incidence of low-birth-weight babies, the socioeconomic background of the mother, the age of the mother, the birth order of the infant, and the genetic background of the mother and child were discussed. Questions were raised about such medical care aspects as the effect on the infant's chance of survival of adequate and inadequate prenatal care, of hospital stay at the time of birth, and of the administration of drugs to the mother before and during parturition. Further questions were raised about the increasing incidence of perinatal deaths attributed to diseases of early infancy and to disorders of uncertain etiology.

There seemed to be no simple, concise explanation for the leveling off or for the unfavorable position of the infant mortality rate in the United States. No single statistical, demographic, or medical factor appeared to account for the international differences observed in the perinatal and infant mortality rates. However, it was not possible to assess the relative portion contributed by each factor. In some areas, especially those associated with medical aspects, data were not available for the evaluation of their impact on infant and perinatal mortality.

As the perinatal and infant mortality rates decrease, the relative effects of artifacts such as underregistration of fetal and infant deaths and differences in definitions and statistical practices increase. More information on these factors is needed for the various countries for future comparative studies. Also, data are needed on factors associated with infant mortality such as socioeconomic conditions, mortality rates among low-birth-weight infants, and the effect of prenatal care and obstetrical practices on perinatal and infant mortality. Accordingly, suggestions for future research have been made.

Unless some major change in the infant mortality rates takes place in the United States, the situation with respect to other countries will only worsen. It is hoped that serious study will be given to the problems of perinatal and infant mortality, and action taken to achieve greater savings of infant lives.



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