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CAUSES AND PREVENTION OF
NEONATAL MORTALITY

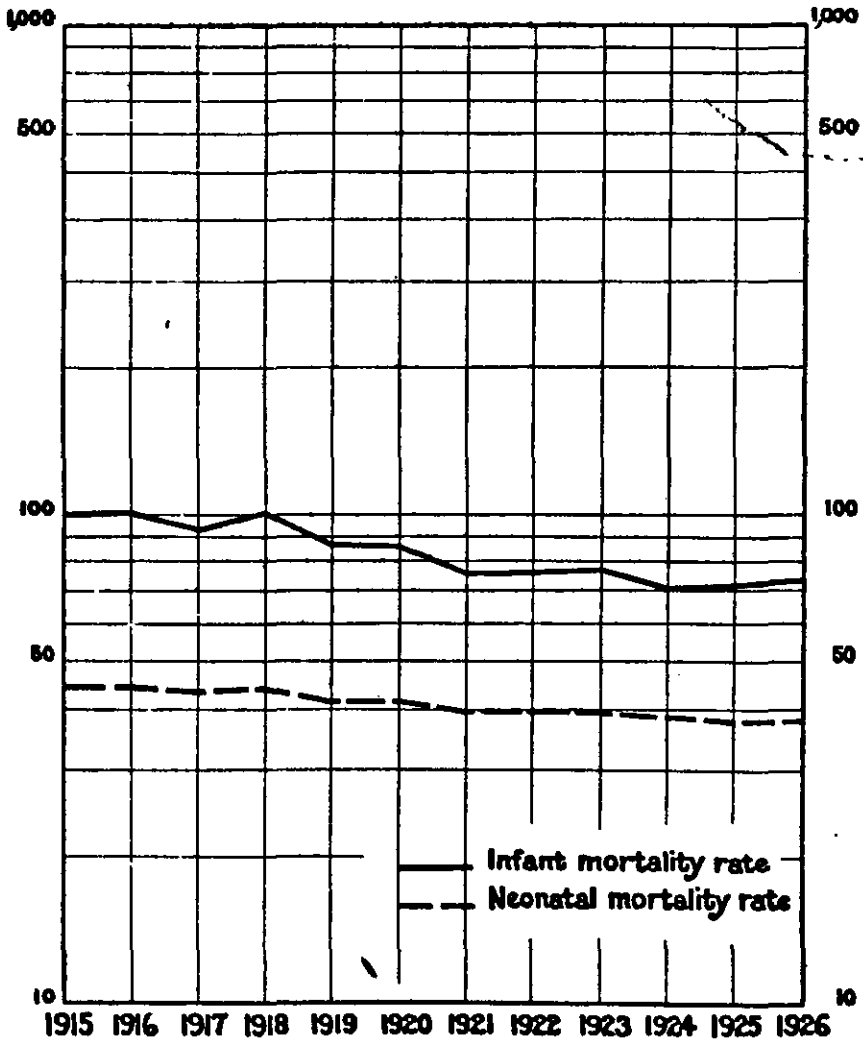
By
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Trend of Infant Mortality and Neonatal Mortality (deaths under 1 month of age), Expanding United States Birth-Registration Area; 1915-1926^{1/}



^{1/}Source: U.S. Bureau of the Census.

CAUSES AND PREVENTION OF NEONATAL MORTALITY

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The aim of this paper is essentially practical. An attempt is made to construct a mosaic of facts concerning neonatal mortality assembled from the studies of many competent investigators. It is hoped that the somber picture here presented will be viewed in the high light of possibilities for the prevention of the outstanding causes of early infant mortality.

While our attention for the moment is focused upon one segment of infant mortality we should not lose sight of the broad scientific foundations already laid for this whole subject. One must refer at the outset to the epoch-making work of Ballantyne, Newsholme, and their confreres; to Budin and Variot; to von Reuss and Ylppö; and to those who have pioneered in preventive pediatrics and obstetrics in this country. The cardinal principles enunciated by Ballantyne in his classic on Antenatal Pathology and Hygiene and expanded in his later writings in all essentials still hold good.

The contributions on neonatal mortality in recent years have been largely compilations of case reports, pathological and serological findings, statistical studies, and clearer definition of terms used in classification. Very little has been added to our intimate knowledge of underlying, or predisposing, causes of early infant mortality.

The main facts concerning neonatal mortality in relation to total mortality are sufficiently well known to demand serious attention. They may be stated briefly as follows:

1. There has been a marked decline in the total infant mortality rates in practically all civilized countries during the last two decades. A critical analysis of these rates reveals that the decline has taken place almost entirely in the period after 1 month of age, while neonatal mortality rates remain about the same.

2. Infant mortality rates as a whole show relatively less reduction during recent years. In the last few years a slight advance in rates has taken place in the expanding birth-registration area of the United States. In some of the States, however, there has been a substantial reduction. The general tendency to approach minimum limits is probably an expression of the law of diminishing return, although this is due to some extent to the admission into the birth-registration area of States showing a higher infant mortality.

¹ Now director, Cleveland Child Health Association.

It is a fallacious assumption that the rates are now near bedrock when a number of localities show rates below 50 and not a few hover about 40. The situation strongly suggests that if further substantial reduction is to be secured emphasis in prevention must be shifted from those causes over which we have gained considerable control to those which thus far have proved refractory to our efforts.

3. Measures employed in public health and preventive medicine which have met with signal success in the latter months of the first year of life have failed to stem the tide of neonatal mortality. Only in certain outstanding endeavors where special preventive obstetric and public-health methods have been used can any commensurate reduction in neonatal and maternal mortality be shown.

4. Infant mortality rates in rural parts of the United States birth-registration area have been uniformly lower than rates for the cities in the same area. The percentage decline in rural rates has paralleled closely that of the cities during the last decade.

5. The infant mortality rates for colored babies are still considerably higher than those for the whites, although a marked percentage reduction in the rates for colored (42 per cent) as compared with white (32 per cent) has taken place in the last 10 years.

6. Time and place variability of neonatal mortality rates becomes less and less marked from 1 month of age back to rates under 1 week and on the first day of life.

7. Causes which underlie mortality from 1 to 12 months of age apparently have little influence upon the under-1-month mortality. The causes which operate in early infant mortality are responsible mainly for fetal deaths, whether of antenatal or intranatal origin. A study of neonatal mortality, therefore, is not complete without consideration of stillbirths and miscarriages.

8. Maternal mortality is so intimately related to early infant mortality that it must be taken into account in sifting the factors of neonatal mortality. The maternal mortality rates have shown very little, if any, decrease in the birth-registration area of the United States since 1915, and these rates are uniformly higher than those found in a number of foreign countries. As a matter of fact, from 1915 to 1924 there was an increase of 14 per cent in maternal mortality rates in the cities and of 5 per cent in the rural areas of the birth-registration area, while there was an actual decrease of 7 per cent for white mothers in the rural districts of the same area. Some of the States where intensive work had been carried on showed greater percentage declines than this. It is very significant that there has been such a decided rise in the rates for white mothers in the cities and a decrease in the rural areas.

9. In spite of the fact that social and economic levels have risen in this country since the World War and that hospital and medical facilities are constantly improving, no general reduction in maternal and neonatal mortality rates can be shown for the birth-registration area, although an encouraging reduction in maternal mortality in some of the States has taken place.

10. No direct correlation is evident between meteorological, industrial, social, economic, and general sanitary conditions and deaths of infants in the early days of life.

11. Considerable data are at hand to confirm the opinion that racial stock has some influence, direct or indirect, upon neonatal mortality. Early infant death rates are significantly lower among babies born to Polish and Italian mothers in this country than among those born to native American mothers. The neonatal mortality rate for Negro babies is exceptionally high. The prevalence of syphilis among the colored population is offered as one explanation for the high rate. How much difference in rates among various nationalities is due to inherent qualities and how much to environmental factors and racial customs has not been definitely determined. One fact is clear, that there is a greater range in variability of infant mortality among babies of mothers from different races in the 1-month to 1-year period than exists under 1 month of age. Neonatal mortality rates for under 1 week and under 1 day vary comparatively little for babies of mothers of different nationalities.

12. Neonatal mortality is higher among first-born babies of young mothers and those becoming mothers late in the childbearing period. It is also higher where short intervals elapse between successive births.

13. Neonatal mortality is always high among multiple births and especially among premature infants.






14. Neonatal mortality is higher among male infants, whether the child dies as a result of antenatal, intranatal, or postnatal causes. The earlier the age of fetus or embryo the greater the proportion of male deaths. Holmes has suggested that this greater male lethal liability may reside in peculiarities of the male chromosomes.

15. An analysis of the causes of neonatal mortality as given in official reports shows that by far the highest percentage of deaths occurs from conditions connected with prematurity. "Prematurity" as a cause of early death has shown but little decline in the United States birth-registration area since 1915. "Congenital malformations" reveals the next highest cause of neonatal deaths and has shown practically no reduction since 1917. "Injuries at birth" has continued to assume greater importance as a cause of early mortality, the rates rising since 1918. This may be accounted for to some degree by better diagnosis and reporting; there may also have been some transference of cause of death from other classifications. Neonatal deaths placed under "congenital debility"—a very unsatisfactory and indefinite term—have decreased in the last 10 years. The rates given for "other diseases of early infancy" have declined slowly. The net result when all causes are combined is a neonatal mortality rate little less than that in 1915. (See accompanying table and chart.)

These facts challenge our best efforts in preventive medicine and public-health measures. Outside professional circles a feeling of complacency often expresses itself in the conviction that so long as the total infant mortality rate continues to decline no great concern need be felt for deaths in early infancy. These are considered due to causes largely beyond our control, and some have urged that neonatal mortality is a selective process which in the long run is beneficial to the race. This same attitude and argument were formerly maintained in regard to infant mortality as a whole.

Neonatal Mortality Rates (deaths under 1 month of age per 1,000 live births) from Specified Causes, Expanding United States Birth-Registration Area; 1915-1926



Premature births  Congenital malformations  Injury at birth 
 Congenital debility  All other and unknown causes 

¹Includes other diseases of early infancy.

Source: U.S. Bureau of the Census.

Those who press the eugenic point of view to its Spartan limits are confronted by several considerations of social and economic importance. It has been shown that the causes operating to increase the number of deaths during the first month of life are also largely responsible for a considerable number of abortions, miscarriages, and stillbirths, and for many maternal deaths. Some of these causes are plainly environmental and have been proved to be preventable. They bear no apparent relation to the constitutional strength or weakness of the child. The causes which lie back of the mortality also increase morbidity. Not all those damaged and diseased from prenatal and intranatal causes die during the first month of life. A considerable number carry over the defects and later become social liabilities. In the United States at the present time approximately 50 per cent of the total infant mortality occurs under 1 month of age, 40 per cent under 1 week, and 20 per cent under 1 day. (See accompanying chart.) In addition, 6 mothers for every 1,000 babies born lose their lives from causes connected with childbirth.

An intimate knowledge of the causes of neonatal mortality is absolutely essential to any adequate program for their prevention. While knowledge of the immediate or direct causes is gradually increasing, there is still much to learn respecting the contributing and predisposing causes and their interrelations. Knowledge in this direction bears an inverse relation to the age of the fetus. Considerable progress has been made in the description and classification of embryonic, fetal, and neonatal defects, but we are still groping after the basic causes of constitutional weakness and congenital malformations.

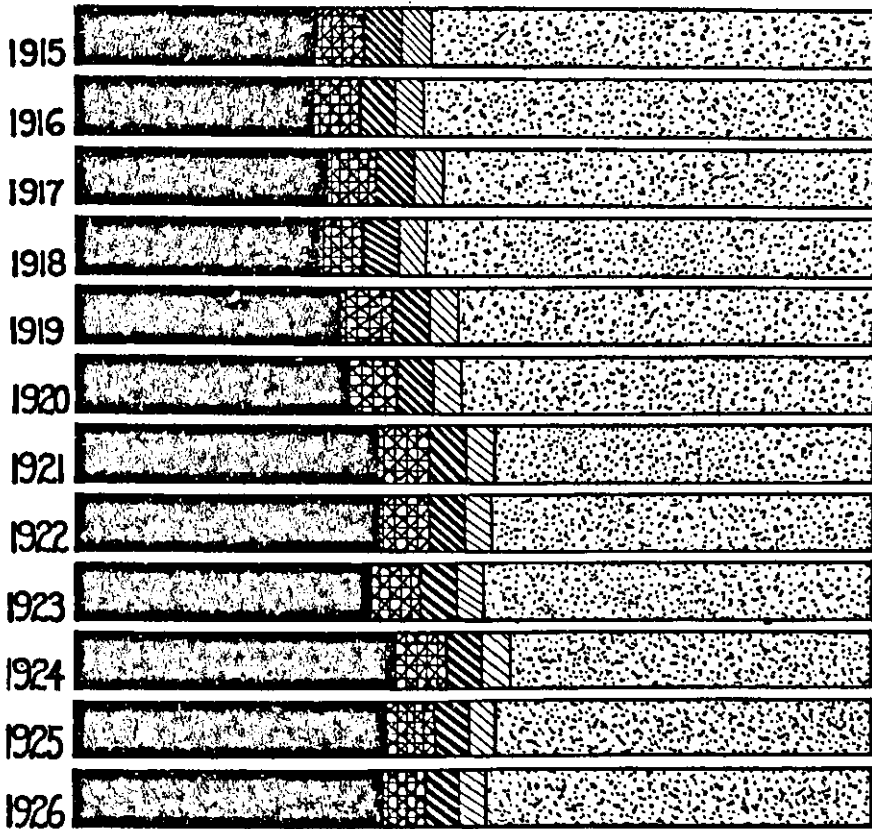
Neonatal mortality rates (deaths under 1 month of age per 1,000 live births) from specified causes, expanding United States birth-registration area; 1915-1926






Cause of death	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
All causes.....	44.4	44.1	43.4	44.2	41.5	41.5	39.7	39.7	39.5	38.6	37.9	37.9
Premature birth.....	17.7	18.3	18.3	19.3	18.3	18.5	17.2	17.3	17.1	17.0	16.4	17.0
Congenital malformations.....	8.0	8.8	4.9	8.0	4.9	4.8	4.7	4.9	4.8	4.6	4.7	4.6
Injury at birth.....	4.1	4.1	3.8	3.3	3.4	3.7	4.1	4.5	4.6	4.8	4.9	4.8
Congenital debility.....	6.3	6.3	5.8	5.9	5.5	5.4	2.4	2.2	2.1	2.0	1.9	1.9
Other diseases, early infancy.....	(1)	(1)	(1)	(1)	(1)	(1)	2.6	2.4	2.5	2.4	2.3	2.1
Diarrhea and enteritis.....	2.6	2.6	2.0	1.9	1.7	1.8	1.5	1.4	1.3	1.2	1.2	1.0
Diseases of the stomach.....	.4	.3	.2	.4	.3	.3	.2	.2	.2	.1	.1	.1
Broncho-pneumonia.....	1.8	1.5	1.4	1.3	1.2	1.2	1.1	1.3	1.3	1.2	1.2	1.2
Pneumonia.....	.6	.6	.7	.7	.8	.8	.4	.5	.5	.5	.4	.4
Bronchitis.....	.6	.5	.6	.5	.4	.4	.3	.3	.2	.2	.2	.2
Byphills.....	.5	.5	.5	.4	.4	.4	.3	.3	.3	.3	.3	.3
Convulsions.....	.8	.7	.6	.6	.5	.5	.5	.4	.4	.4	.4	.3
All other and unknown or ill-defined causes.....	3.6	3.3	4.6	4.9	6.4	4.1	4.2	4.3	4.3	4.0	3.9	3.9

¹ Included with congenital debility.

The studies of Mall, Wilson, Morgan, Bateson, and others on the mechanism of heredity and development strengthen the belief that innate constitutional factors have a decided part to play in determining weakness or defectiveness of the individual and consequently his ability to survive under unfavorable conditions. We may recoil from the idea that neonatal mortality is a selective process, but we must admit that great inequalities exist at birth in vigor, resistance,

Percentage of Deaths under 1 Year of Age Occurring at Certain Periods of the First Year of Life, Expanding United States Birth-Registration Area; 1915-1926



Under 1 week 
 1 week, under 2 
 2 weeks, under 3 
 3 weeks, under 1 month 
 1 month, under 1 year 

Source: U. S. Bureau of the Census.

Those who press the eugenic point of view to its Spartan limits are confronted by several considerations of social and economic importance. It has been shown that the causes operating to increase the number of deaths during the first month of life are also largely responsible for a considerable number of abortions, miscarriages, and stillbirths, and for many maternal deaths. Some of these causes are plainly environmental and have been proved to be preventable. They bear no apparent relation to the constitutional strength or weakness of the child. The causes which lie back of the mortality also increase morbidity. Not all those damaged and diseased from prenatal and intranatal causes die during the first month of life. A considerable number carry over the defects and later become social liabilities. In the United States at the present time approximately 50 per cent of the total infant mortality occurs under 1 month of age, 40 per cent under 1 week, and 20 per cent under 1 day. (See accompanying chart.) In addition, 6 mothers for every 1,000 babies born lose their lives from causes connected with childbirth.

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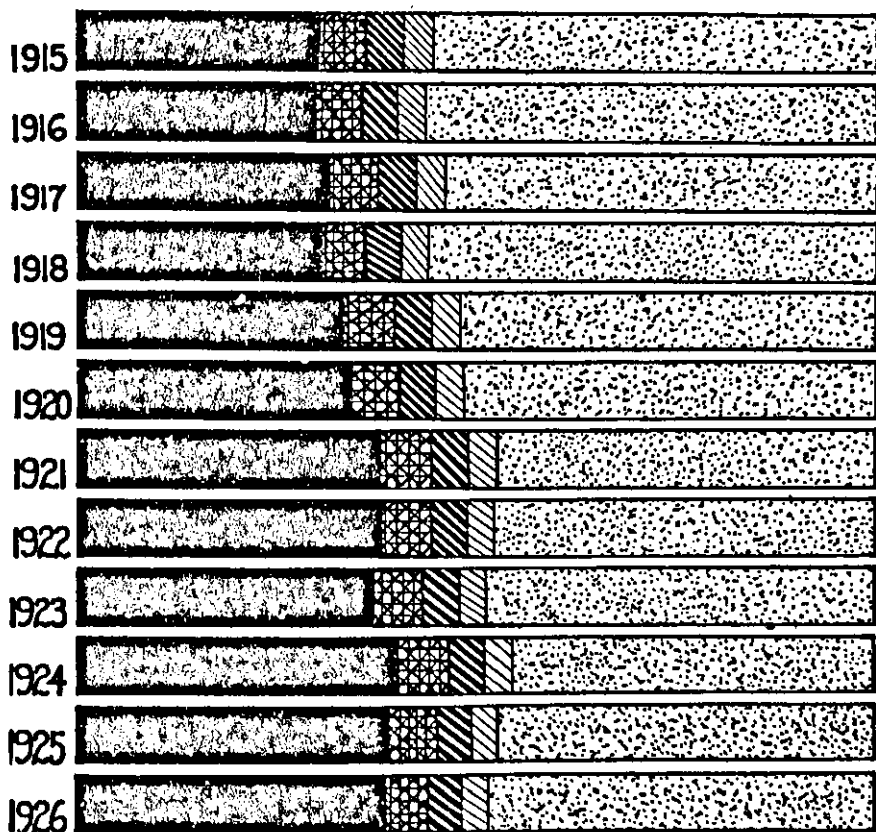
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Bronchitis.....	.6	.5	.6	.5	.4	.4	.4	.3	.2	.2	.2	.2
Syphilis.....	.5	.6	.5	.4	.4	.4	.3	.3	.3	.3	.3	.3
Convulsions.....	.8	.7	.6	.6	.6	.5	.4	.4	.4	.4	.4	.3
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Source: U. S. Bureau of the Census.
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and immunity, and adaptability to environment, for which a plausible explanation may be found in intrinsic or constitutional differences. Granting all that heredity may contribute, we are forced to conclude that a number of the factors known to threaten immature life are strictly environmental and can be prevented in large measure by thorough prenatal care and skilled attention at the time of birth. Surely no one would seriously urge that congenital syphilis and birth injuries due to bungling obstetrics are instruments for the elimination of the unfit.

CAUSES OF NEONATAL MORTALITY

The main task set for this paper is to present the causes of early infant deaths, analyze the contributing and predisposing factors, and suggest suitable means for their prevention or amelioration. At the threshold we are met with difficulties of classification. While distinct progress has been made in formulating more exact classification, there is still room in the official statistics of stillbirths and neonatal deaths to bring out more clearly the relative importance of the various factors involved. Statistics of stillbirths were not compiled by the United States Bureau of the Census until 1918. In the reports issued since then over one-third of the stillbirths are classified under "causes not specified and unknown." The official figures are compiled from reports of physicians attending the cases and are based almost entirely upon clinical diagnosis or opinion. The exact cause of death is very rarely determined by autopsy findings. This gives rise to inexact reports and to transference of certain causes of death from year to year.

In addition to the birth, stillbirth, and infant-mortality statistics for the birth-registration area of the United States there are statistical studies from certain life-insurance companies, from lying-in hospitals and other institutions, and from special researches of individuals in which social, clinical, pathological, and serological investigations have been made. The field studies on maternal and infant mortality conducted by the United States Children's Bureau have been especially helpful in indicating the complexity of the problems involved and the interrelation of various factors.

A convenient classification relating to the period in which morbid changes are initiated is that originally proposed by Ballantyne and modified by Holland. The latter drops the ambiguous term "still-birth" and in its place uses simply the designation "fetal death." Fetal deaths and neonatal deaths may both be classified under this scheme as follows:

1. Antenatal: Fetal or neonatal deaths from causes operating before the onset of labor in which either maternal or fetal abnormalities or diseases play the leading part.
2. Intranatal: Deaths from causes—largely traumatic—operative during the course of labor, whether spontaneous or instrumental.
3. Postnatal: Neonatal deaths from causes operating immediately after birth and during the first days of life.

In statistical practice birth is taken to mean "the instant of complete separation of the entire body of the child from the body of the mother. The umbilical cord need not be cut or the placenta detached

in order to constitute complete birth for registration purposes. A child dead or dying a moment before the instant of birth is a stillbirth, and one dying a moment, no matter how brief, after birth, was a living child, and should not be registered as a stillbirth." ²

In this paper a modification of the classifications set forth by Balantyne, Holland, Julius Hess, Ehrenfest, and others is attempted. A grouping under direct, contributing, and predisposing causes will be carried out as far as possible, although it is recognized that these often act and react inextricably one upon the other.

PREMATURE BIRTH

In all official mortality statistics premature birth takes a leading place as a cause of neonatal mortality. Prematurity is a term loosely applied to many babies who are small, poorly developed, and weakly. The criteria of prematurity should be more clearly defined and generally accepted by the medical profession. The practical classification of Dr. Julius Hess may be taken as quite satisfactory. He states: "It may be understood that when the designation premature is used, it refers to those infants born three weeks or more before the usual termination of pregnancy." ³ He also makes clear that "there is another class of infants who may be considered in practically the same category as the prematures. These are the weaklings, infants born possibly at term, or nearly so, yet who have suffered more or less severely during their intrauterine existence through factors which interfered with their nutrition and consequently their development. They are classed as congenitally diseased or debilitated."

The following points should always be taken into account in judging of prematurity:

1. Length of intrauterine life: A period of gestation of less than 260 days.
2. Weight and length of neonate: Birth weight less than 2,500 grams and length less than 45 centimeters.
3. Functional incapacity, especially as to sucking, digestion, and heat regulation of the body.
4. Clinical evidence of general weakness or lack of development.

The direct or immediate causes of prematurity may conveniently be grouped under the following headings:

1. Trauma or mechanical injuries undoubtedly play no small part in bringing on premature labor. Such injuries as falls, strains, blows on the abdomen, and sudden jolts have long been recognized as direct causes. It needs to be emphasized that long or rough journeys in trains or automobiles may bring about the same result. Fatiguing or exhausting work in the latter months of pregnancy must be considered. Induced abortions should also be classed under this heading.

2. Nervous factors. Here it is necessary simply to mention the major emotions such as fright and anger, severe pain, shock, and

¹ Mortality Statistics, 1907, p. 490. U. S. Bureau of the Census. Washington, 1909.
² Hess, Julius H.: Premature and Congenitally Diseased Infants, p. 17. Lea & Febiger, Philadelphia, 1922.

reflex stimuli from the genitalia and breast. Exposure to sudden changes in temperature, especially hyperpyrexia, may be mentioned. Epileptic and choreic seizures sometimes initiate premature labor.

3. Intrauterine abnormalities such as placenta prævia, premature rupture of the membranes, adhesion of the membranes, placental degeneration, endometritis, hydramnios, and tumors may each act as an exciting cause of premature birth. Extensive cervical tears with relaxation of the outlet are responsible for a certain percentage of cases.

4. Acute and chronic infections. Prematurity follows in the wake of acute communicable diseases as influenza, pneumonia, typhoid, and smallpox. Syphilis is looked upon as an outstanding cause of premature termination of pregnancy. Tuberculosis, while a distinct contributing cause, is less frequently responsible directly for premature birth. The focal infections undoubtedly act as predisposing or contributing causes, and in the case of operations for appendicitis, cholecystitis, and kidney infection may set off premature labor.

5. Acute and chronic intoxications with lead, mercury, arsenic, phosphorus, ergot, carbon monoxide, alcohol, and other organic and inorganic poisons are well known as abortifacients.

6. Toxemias of pregnancy. Eclampsia frequently eventuates in premature labor or is a distinct indication to induce such labor. Chronic nephritis may act as a contributing or exciting cause, and severe hyperemesis is known to be followed in a number of cases by miscarriage or premature birth.

7. Maternal heart disease. Hess states that "premature birth occurs in 30 or 35 per cent of the cases of broken compensation in heart disease."⁴

8. Congenital deformities and malpositions of fetus such as hydrocephalus and spina bifida, and abnormal presentations such as breech, transverse, and face, may be exciting causes. Malpositions of the uterus are likely to contribute to the difficulties.

9. Endocrine dysfunction. There is a growing conviction that disordered endocrine function in mother and unborn child may have considerable to do with initiating a premature birth. Thus there are a considerable number of cases in which the mother is suffering from diabetes or exophthalmic goiter or in which the newborn has congenital goiter or enlarged thymus.

In any study of prematurity the contributing causes should be carefully considered. They may be classified briefly as follows:

1. Multiple pregnancy. From 60 to 70 per cent of multiple pregnancies eventuate in premature birth.

2. Factors influencing fetal nutrition. Under this heading may be placed constitutional weakness of the mother from debilitating diseases, such as dissipation and anemia, and nutritional deficiencies in quantity, quality, or vitamin content. Diseases of the placenta sometimes play a rôle.

3. Emotional instability of the mother.

4. Early and late pregnancies and short intervals between successive births have already been considered under another head.

⁴ *Ibid.*, p. 24.

5. Sex may be looked upon as a contributing factor, as the male consistently shows a higher rate of prematurity, as also of neonatal mortality.

6. Habit of abortion and miscarriage. Some authorities lay stress upon the early termination of pregnancies in succession without any apparent or demonstrable exciting cause. It has recently been suggested that this is associated with some corpus luteum dysfunction.

The predisposing causes of premature birth are many and complex, but in general they may be categorically stated under the following:

1. Lack of suitable prenatal care, which should be begun early and continued regularly throughout pregnancy.

2. Overwork and anxiety on the part of the mother.

3. Work away from home during the pregnancy, especially fatiguing industrial labor.

4. Pelvic and spinal deformities, such as result from rickets, tuberculosis, etc.

5. Insufficient and unbalanced dietary of the mother.

6. Certain pathologic blood states, such as pernicious anemia, leukemia, and hemorrhagic diathesis.

The incidence of premature births has been variously given by different observers as 5 to 25 per cent. This wide range is due, no doubt, to the different criteria used in judging prematurity as well the character of population from which the cases were derived. The higher percentages are possibly due to the inclusion of infants congenitally weak and undersized, but full term. In estimating the precise importance of prematurity as a cause of neonatal death there is still some difference of opinion, although all are agreed that it is one of the major causes. The present tendency seems to be to seek the direct or underlying causes of prematurity and assign an anatomicopathologic basis for death. This raises such causes as syphilis and toxemia to places of considerable importance.

It is readily seen from the enumeration of causes as set forth above that though there are many possible combinations and frequently no one cause can be given for prematurity, most of the conditions mentioned are preventable to some degree. It has been amply demonstrated by competent obstetricians that prematurity due to syphilis and the toxemias of pregnancy can be reduced considerably.

BIRTH INJURIES

Birth injuries as a cause of neonatal death are sufficiently obvious to need but little explanation. Its importance grows from year to year. It has been shown in a number of careful studies that intracranial hemorrhage is a decided factor in neonatal mortality. From 40 to 50 per cent of neonatal deaths reveal intracranial hemorrhages on autopsy. Approximately 10 per cent of all newborns show some blood in the spinal fluid. Prematurity is mentioned by many observers as the greatest single predisposing cause of intracranial hemorrhage. Ehrenfest states that "mechanical factors, probably

almost always, are the immediate and direct causes of the traumatic injury."* It is reasonable to infer that more extensive damage will result if the brain is unusually soft and the vessel walls friable. Prematurity and syphilis predispose to such conditions. Other birth injuries include cerebral concussion, hemorrhages into the cord, and visceral hemorrhages.

It should be made clear, as Ehrenfest states, that "the fact is now firmly established that also the physiological traumatism of a normal labor is sufficient to lead to serious consequences if other coincident conditions supply those predisposing and contributing elements which will cause the normal physiological effects of the birth trauma to attain pathological importance."⁶

Very little comment is necessary here on the causes of birth injuries. They may readily be listed under the following headings:

A. Direct or immediate causes.

1. Trauma. Mechanical factors.
2. Undue compression of the head. Sudden release of molded head.
3. Unequal or too sudden changes in pressure.
4. Unskillful application of instruments. High forceps.
5. Internal podalic version and rapid extraction.
6. Extraction of shoulders and after coming head in breech cases.
7. Injudicious use of pueritin and ergot in early stages of labor.
8. Rough handling of child during resuscitation.

B. Contributing causes (often difficult to separate from direct).

1. Pelvic abnormalities—rachitic, generally contracted, exostoses.
2. Abnormal presentations, especially breech.
3. Maternal or fetal dystocia due to the above causes and others.
4. Hemorrhagic diathesis. Delayed coagulation time.
5. Precipitate labors. Premature rupture of membranes.
6. Multiple births, especially prematures.
7. Rigid cervix and unyielding perineum.

C. Predisposing causes (difficult to separate from contributing).

1. Prematurity. See causes mentioned under Prematurity, page 9.
2. Syphilis.
3. Asphyxia. Often a result of injury rather than a cause.
4. Toxemias of pregnancy, especially eclampsia.
5. Acute infections and intoxications of mother. See under Prematurity 4 and 5, page 10.

While it is fully recognized that birth injuries are not always the fault of the attendant at birth it is evident that many of the causes leading to such injury may be prevented if proper prenatal care and skilled obstetrical service are given. Prenatal care does not guarantee a safe delivery at the hands of a careless or unskilled physician or midwife. It should also be borne in mind that too conservative treatment—"waiting for Nature to take her course"—may be just as disastrous as radical interference. Sound judgment

* Ehrenfest, Hugo: *Birth Injuries of the Child*, p. 34. D. Appleton & Co., New York, 1922.

⁶ *Ibid.*, p. 34.

coupled with experienced technical skill is demanded for optimum results.

CONGENITAL MALFORMATIONS

Very little is known as to the primary causes of congenital malformations and developmental defects. Adhesions of the membranes, abnormalities of the cord and placenta have been considered. Syphilis and alcoholism have been suggested among the causes. Chronic intoxications may play a part. Dysfunction of maternal endocrines is mentioned by some observers. Malformations are more likely to occur toward the end of the reproductive period. So little is known about contributing and predisposing causes that no practical suggestions can be offered here as to prevention.

CONGENITAL DEBILITY

It would be a distinct advantage to exact classification to drop such indefinite terms as congenital weakness, congenital debility, marasmus, and atrophy, and assign as causes of neonatal death the causes which lie back of these clinical pictures. The last two terms have already been dropped from official statistics of death in this country, and "congenital debility" as a cause of early death is being used less and less.

Maternal disorders and disabilities have been covered largely under other classifications and need not be repeated here. Certain placental and cord anomalies, such as placenta prævia, premature separation of the placenta, prolapse of cord, infarction of placenta, and hematoma, may be mentioned as possibilities.

Injudicious or rough handling of the neonate may turn the balance in a weakling or premature. Undue exposure is especially to be guarded against in the case of prematures. Such babies should always have special attention in a thoroughly equipped hospital at the hands of a well-qualified pediatricist. The practice of turning the baby over to a pediatricist as soon after birth as possible is growing and should be encouraged. Improper methods of feeding in the early weeks of life may take months to correct.

ACUTE INFECTIONS

There remain to mention in a few words the acute infections of the newborn. Neonatal pneumonias occur frequently enough to bear them in mind. Septic and gonorrhœal infections sometimes prove serious in maternity hospitals. Tetanus of the newborn is fortunately now a rare disease. The newborn is relatively immune to a number of the common communicable diseases, such as diphtheria and scarlet fever, but is very susceptible to tuberculosis and septic infection.

The incidence of dead births and neonatal deaths from specific causes, as found by a number of observers, is shown in the accompanying table. The work of Holland is especially commendable for its thoroughness and gives a fairly complete picture of neonatal mortality in England.

Comparison of the proportion of dead births and neonatal deaths due to specified causes as shown by various observers¹

Causes	Holland, London (260 cases)	Williams, Baltimore (273 cases)	Holt, New York (636 cases)	McQuarrie, San Francisco (97 cases)
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Complications of labor.....	28.3	22.4	31.1	37.1
Antepartum hemorrhage.....	22.3	9.9	7.4	2.0
Toxemia of pregnancy.....	8.6	11.7	9.9	9.2
Syphilis (certain, probable, and possible).....	15.3	12.5	8.3	15.5
Maternal diseases.....	8.6	17.2	28.8	8.2
Placental states and various.....				
Fetal states.....	5.6	6.6	3.0	5.2
Prematurity.....	.3	5.2	2.8	5.2
Cause unknown.....	10.7	14.3	13.7	17.5

¹ Medical Research Council (Great Britain): A Clinical and Pathological Study of 1,673 Cases of Dead Births and Neonatal Deaths, by Eardley L. Holland and Janet E. Lane-Clayton, p. 19. Special Report Series No. 100. London, 1926.

The incidence of syphilis in the general population, in pregnant women, and in the newborn is admirably set forth in graphs presented in Cruickshank's study, "Maternal Syphilis as a Cause of Death of the Fetus and of the Newborn Child."¹ Considerable variation in percentage of positive Wassermann reactions is found in the reports of the different observers. This may be accounted for by the methods of investigation, by type of cases investigated, and by selection of material. The most recent and thorough investigations of Adair and O'Brien, Holland, Jeans, and Williams would indicate that the incidence of congenital syphilis in the white population is between 5 and 10 per cent. Williams's figures should always be analyzed as to white and colored cases. Autopsy findings raise the percentage of congenital syphilis when compared with results from Wassermann reactions alone.

PREVENTION OF NEONATAL MORTALITY

1. Modern preventive medicine.

A survey of this entire subject forces one to the conclusion that the major responsibility for the reduction of maternal and neonatal mortality falls upon the shoulders of the medical profession, especially upon those who essay to attend women at childbirth. The midwife may be a factor in some of the Southern States, but she is certainly not a main factor in the problem. Skillful and judicious obstetrics is the sine qua non of the prevention of neonatal mortality.

While it is frequently said that the day of the general practitioner is rapidly passing, it is nevertheless true that he is still doing the bulk of the obstetric practice in this country. In this he is frequently attempting to follow methods carried out by specialists in this field. Procedures which specialists in obstetrics may safely follow in hospital practice with trained assistants often prove disastrous when attempted single-handed by the general practitioner. Consultation is often called for too late and fails to avert damage already done to mother or child.

¹ By John Norman Cruickshank. Child Life Investigations. Medical Research Council Special Report Series No. 82. London, 1924.

An essential in the reduction of neonatal mortality is thorough preliminary training in the fields of preventive obstetrics and pediatrics, although other branches of medicine may contribute. The medical student should receive expert instruction in the technique of obstetrics and have sufficient practical training under competent teachers to be able to conduct a normal delivery, to detect departures from normal, and to decide whether or not operative measures are indicated. The need for thorough prenatal care and adequate home or hospital facilities should be drilled into every medical student. More general use of the early Wassermann reaction is desirable. The importance of neonatal care, especially in the case of prematures, should be emphasized. In general the baby should be handed over to a competent pediatricist as soon after birth as possible. In this way a number of premature and other weakly babies may be saved and the feeding of normal babies started right.

Moral stamina is often necessary to withstand the entreaties of patient and family, and sometimes of the family physician himself, to shorten the time of labor by operative procedures and rapid extraction. The indications for the proper use of ergot and pituitrin should be taught thoroughly in the medical schools. The medical student should be taught the preventive value of maternity hospitals or maternity services of general hospitals and out-patient departments.

With the knowledge and skillful technique already at hand it has been possible to demonstrate in certain organized pieces of maternity work that the neonatal and the maternal mortality can be reduced at least from one-third to one-half of the present general rates. In a recent study of infant mortality in Buffalo covering some 62,000 births, Hollingshead has shown that the percentage of neonatal deaths in the hands of physicians and midwives varies considerably in home and in hospital practice. In one group of 20 physicians who attended 14,704 live births the neonatal mortality rate under 2 weeks of age varied from 1.5 per 100 live births to 8.6, the average for the group being 4.6. In a second group of 33 physicians the rates ranged from 1.6 per 100 live births to 10.6, with an average of 4.3 for the group.

Midwives attended 16 per cent of the births occurring in Buffalo during the five years. For each 100 babies attended by midwives there were 2 deaths under 2 weeks of age. Thirty-three per cent of all births during the five years occurred in hospitals [with] * * * a mortality rate of 4.5 per 100. In two hospitals this average rate was more than doubled, 10.9 and 10.6 per 100 deliveries. In the three strictly maternity hospitals, the rates were all below the average of 4.5 per 100 deliveries. The mortality rates in the 13 hospitals in Buffalo ranged from 1.3 to 10.9.*

Some very interesting figures have recently been placed in my hands by Dr. Adelaide Brown, of San Francisco, showing the maternal mortality in one of the San Francisco hospitals from 1919 to November, 1927, inclusive. During that period there were 5,187 obstetrical cases under private physicians' care in the hospital. Twenty-two of these died of causes connected with childbirth, giving

* Hollingshead, Frances M.: The Five-Year Infant-Mortality Study. Sanitary Bulletin, published monthly by the Buffalo (N. Y.) Department of Health, August-September, 1927, pp. 2-6.

a rate of 4.2 per 1,000 confinements, while in the same hospital during the same period 1,129 cases were delivered in the regular service by internes under direction of the chief of staff with only 2 maternal deaths, giving a rate of 1.7. The latter cases had had prenatal care under the maternity service of the hospital. No record is at hand to show how much prenatal care had been given by the private physicians. These figures and others exhibit a wide range in neonatal and maternal mortality and seem to point to differences in ability of physicians in the conduct of obstetric cases whether in home or in hospital practice.

2. Modern public-health methods.

It is fallacious to believe that "every physician's office is a health center." All are agreed that the modern physician should be prepared to practice preventive medicine, but community resources must be brought to play upon every maternity case in a much broader way than is possible in the physician's office, no matter how well equipped. The public has come to feel that the first responsibility for a successful outcome of pregnancy rests with the attendant at birth, but that while his individual responsibility is great he should call to his aid other professional and community resources. The practice of obstetrics is a community responsibility. It is practically impossible for the obstetrician to assume responsibility for all that prenatal care implies; for education of parents; for provision of suitable hospitalization, the keeping of exact records, compilation of statistics, follow-up in homes, and the research necessary to draw together all the factors bearing upon the reduction of early infant mortality. It has been clearly demonstrated that the physician must take advantage of the best public-health methods of the community in order to secure satisfactory results. These may be listed as follows:

- (a) Prenatal centers in connection with community health centers.
- (b) Facilities for public-health nursing. Follow-up of cases.
- (c) Registration, licensing, and supervision of all midwives and thorough training for those who have demonstrated their ability to conduct normal deliveries. This is especially necessary in the South and in congested centers of population.
- (d) Public-health clinical facilities for venereal-disease diagnosis and treatment with social and nursing follow-up.
- (e) Maternity centers. Maternity hospitals. Prematurity care.
- (f) Education of the public to demand better obstetric practice as to importance of adequate prenatal care, skilled obstetrics, and hospitalization.
- (g) Better birth registration. Follow-up of all stillbirths and neonatal deaths with determination of cause, if possible.

3. More complete and accurate vital statistics.

- (a) More uniform methods of gathering and tabulating data. These may be best secured by having every State in the birth and death registration areas of the United States.
- (b) More exact classification of stillbirths and neonatal deaths as to time, causation, and contributing causes.

- (c) More prompt compilation and timely publication of statistics. Correlation of the outstanding data.
- (d) More systematic use of local vital statistics.

4. Maternity benefits.

Some form of maternity benefits is urgently needed in this country. This may be provided through existing insurance companies as health insurance or by means of sickness benefits in which the prospective mother participates. The increasing cost of obstetric service, especially in the large cities, can not be borne without great hardship by a large section of middle-class women unless some relief can be afforded through such insurance, "home helps," or medical and nursing service at rates which the people can afford. Maternity is a community asset. Skilled medical, nursing, and hospital care should be afforded all those who become mothers whatever their economic circumstances. One of the most necessary services is that of home helps, and this might well be provided for by some form of benefit insurance. The results obtained thus far by certain insurance companies in making provision for a partial nursing service to their policyholders amply justifies the extension of such service to the large middle-class population.

5. Research.

There is need for a number of carefully planned community studies of the intimate conditions surrounding maternity and infancy. A study of the mothers and babies who survive as well as those who die would add incomparably to its value. The study should be continued over a sufficient period and should trace the history of a sufficiently large group to give reliable statistical results. Such studies as are now being conducted by the United States Children's Bureau and the intensive study in Berkeley carried on through the University of California Institute of Child Welfare should yield results which will help to solve some of the problems. Some of the points to be covered are:

- (a) Complete study of pregnancy in the light of whole family background.
- (b) More complete records of pregnancy and its outcome.
- (c) Painstaking and prolonged observations of cases.
- (d) More careful autopsy study of dead fetuses and neonatal deaths.

6. Parental and preparental education.

In point of time the education of parents should be the first item for discussion instead of the last. Without the cooperation of the parents very little of permanent value can be accomplished. The methods of securing this cooperation can not be discussed here, but a few of the items which should be included in any plan of instruction are the following:

- (a) Importance of early and continued prenatal care.
- (b) Choice of a physician of good judgment and obstetric skill.
- (c) Importance of prevention of acute communicable diseases and immunization for some of them.
- (d) Importance of prevention of syphilis. Desirability of Wassermann test as a routine procedure.
- (e) Demand for adequate hospital care.

- (f) Dispelling notion that every labor should be hastened and that version and extraction, forceps delivery, and Cesarean-section can meet all exigencies.
- (g) Placing before parents results of good work done by community organizations for maternity care.
- (h) Urging upon parents the importance of some form of insurance to take care of emergencies and to meet extra demands upon mother at the time of childbirth and thereafter.

UNITED STATES DEPARTMENT OF LABOR

JAMES J. DAVIS, *Secretary*

CHILDREN'S BUREAU

GRACE ABBOTT, *Chief*PREVENTION OF NEONATAL MORTALITY FROM
THE OBSTETRICIAN'S POINT OF VIEW

By

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