Data on congenital malformations reported in New York City, 1958-1959, are presented, analyzed, and discussed. The authors indicate what can be learned from this information, its limitations, and how the latter may be alleviated or removed.

REPORTED CONGENITAL MALFORMATIONS IN NEW YORK CITY, 1958-1959

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THE shocking "thalidomide incident" aroused widespread concern and has stimulated much activity directed toward establishment of methods to prevent a recurrence by more rigorous testing of therapeutic drugs and by systematic compilation of data on malformations in such a way that unusual increases in their frequency in time or space may be relatively quickly detected. There is in addition, a burgeoning interest in the investigation of the etiology of congenital malformations in which epidemiologic methods can play a part. Where reporting procedures already exist, it should be possible to bring them to the state of completeness and accuracy that would produce data pertinent for both a monitoring or surveillance system and for epidemiologic research.

Any system of surveillance intended to identify reasonably quickly an increased incidence of congenital malformation must rely on a reporting procedure, whether attached to or independent of the vital registration system. Accordingly, it appears useful to review data derived from routine vital records with particular reference to their limitations and the restrictions that have been arbitrarily added in order merely to facilitate routine handling of the data. Some of the limitations cannot be modified; others are susceptible of alleviation by intensive attention to the reporting mechanism. The arbitrary restrictions can be removed if and when the need arises.

Congenital malformations have been reportable on birth and fetal death certificates in New York City since 1947. The pertinent item on these records has essentially the format:

Congenital malformations? (Circle one)
Questionable Yes No
Describe _____

It must be noted immediately that births are reportable in New York City within 48 hours of the delivery. Hence, reports of anomalies on birth certificates are necessarily restricted to those recognized almost immediately after delivery. Time requirements on filing of fetal death records also exist. Moreover, a congenital malformation may be reported separately and possibly considerably later as cause of an infant death even though no mention of the anomaly was made on the infant's birth certificate, either through neglect or because the malformation had not been noted at

the time the birth certificate was prepared.

Unduplicated Counts of Reported Malformations

Until 1960, reported malformations were coded according to the four-digit detailed list of the International Statistical Classification of Diseases, Injuries, and Causes of Death (ISC).[1] Causes of death continue to be so coded, but to conserve columns on the punched cards for births, a one-digit code has been used since 1960 for malformations in response to this item on the birth and fetal death records. (This is one of the avoidable restrictions mentioned earlier.) The tabulations presented here pertain to 1958 and 1959, the last two years for which data were coded on all records in the detailed categories of the ISC, but tabulations were prepared only on the basis of three-digit groups.

Counts were made of all congenital malformations reported among deliveries of live births or of fetal deaths of 20 or more weeks' gestation. To these were added all infant deaths ascribed to congenital malformations *if* the malformation had not been reported on the corresponding live birth record. Hence, the data represent an unduplicated count of all deliveries in 1958 or 1959 in which a congenital anomaly was reported on a certificate filed with the Department of Health. Among the total 344,542 such deliveries in the two years, 5,152 involved a congenital malformation. Of these malformations, 3,558, or 69.1 per cent, were reported on live birth certificates; 450, or 8.7 per cent, on fetal death certificates; and 1,144, or 22.2 per cent, were found on infant death records where the malformation had not been mentioned on the infant's birth certificate.

These figures, incomplete though they may be, suggest the extent of understatement that will exist if any single source of information is neglected in seeking to determine the incidence* of congenital malformations at or close to term. In this series, a total reported incidence of 15.3 per 1,000 live births was observed. The rate based on malformations reported only on the live birth certificates was 10.6, close to the 11.0 rate reported among live births in British Columbia.[2] Those added by fetal deaths represent a rate of 1.3, while causes of infant deaths contributed 3.4 to the total reported rate. It is of consequence that the rate of reported congenital malformations among the intermediate and the late fetal deaths is 52.1 per 1,000 such events (450 malformations in 8,629 fetal deaths), or about five times their frequency as reported among the live born infants. Some malformations may impose a greater probability of death before delivery and hence, at least in part, account for their higher frequency among fetal deaths; it is also possible that such death encourages reporting of anomalies that could account for the fetal loss or that autopsy has contributed to their recognition.

The brief time period allowed for preparing and filing certificates restricts, as mentioned previously, conditions possible to report to those recognizable at birth or, at most, during the initial pediatric examination where such an examination is routinely made. Furthermore, even though an anomaly is recognized, it must be recorded on the hospital chart and then on the birth certificate. At either of these points failure may occur. There is no doubt that such failures have occurred, but no data on their extent are presently available for New York City.

In addition, for this series, only a single malformation was coded and tabu-

* Incidence is used here, since it is the common term applied. However, it should be recognized that we cannot actually count occurrence figures because we do not know how many affected embryos or fetuses were lost before the 20th week of gestation. Actually, these rates are measures of *prevalence* at or close to term.

lated. In the cases derived solely from infant death records, it is that charged with the cause of death. For the live births and fetal deaths, it is the first one mentioned by the physician if more than one specific anomaly was reported. Because of these limitations, the data must be discussed in descriptive rather than analytic fashion. It is clear, however, that a system intended for surveillance can and must provide for regular evaluation of completeness of reporting of recognized abnormalities and its improvement. It is equally obvious that all reported information can be utilized rather than excluding some of it in the event of multiple anomalies.

Gross Prevalence at Delivery

The figure of 15.3 malformations per 1,000 live births observed in this series compares favorably with that observed elsewhere for over-all frequency observable at birth.[3] However, the agreement is more superficial than real. Malformations appear to be more frequent among infants weighing less than 2,501 grams at birth; therefore, inclusion of intermediate fetal deaths (20-27 weeks' gestation) in the New York City data tends to inflate the figure in comparison with series counting only those of 28 or more weeks of gestation. Moreover, the specific conditions counted (e.g., inclussion or exclusion of hemangioma and lymphangioma) add a further questionable dimension. The counting of every malformation observed in each child, rather than a single anomaly as in this study, will also increase the total counts. This question of inclusions arises in every attempt to compare series from different sources, as does the associated question of definition of terms. It is imperative, therefore, that any surveillance system have definite stipulations on these points so that comparison of data from place to place or from time to time may be possible.

Investigation of the etiology of malformations in any case will not be furthered by data restricted to total numbers of all malformations. Research on specific anomalies will likely be more fruitful.[4,5] Hence, it is of more value if we hereafter review the data in less gross, if not precise, terms. Even with the three-digit rubrics of the ISC, used for this study, the inclusions may be too varied for etiologic determinations but still may be epidemiologically useful. The small numbers that plague all epidemiologic studies of malformations are evident here also when the data have to be thus subdivided.

At this point, it may seem appropriate, with all the restrictions attached to the data, to pack up and go home. However, with a sophisticated and discriminating audience, it seems safe to look at the variations observed in reported malformations to see whether some suggestive relationships can be extracted. For this purpose it is assumed that deficiencies in reporting, whether due to inability to diagnose or failure to report, and exclusions based on processing practicalities, affect equally all segments of the populations under consideration.

Malformations by Ethnic Group

In Table 1 the reported malformations are presented according to three ethnic groups: white, nonwhite, and Puerto Rican (i.e., mother born on that island). In Table 2, these rates are given separately for reports originating from voluntary, municipal, and private hospitals. Those from the voluntary hospitals are further subdivided according to service. These two tables are considered jointly. Inability to recognize anomalies at birth should, generally, be uniform regardless of place of birth. Reporting failures should, furthermore, tend to cancel out, if random, or, if not random, should lend to differences

Table 1—Numbers and Rates per 1,000 Live Births of Congenital Malformations Reported on Vital Records, by Ethnic Group: New York City, 1958 and 1959

ISC Rubric	Congenital Malformation	Numbers				Rates per 1,000 Live Births			
		All Deliveries	White	Non-white	Puerto Rican	All Deliveries	White	Non-white	Puerto Rican
228	Hemangioma, lymphangioma	158	108	33	17	0.5	0.5	0.5	0.5
140–239	Other neoplasms	70	48	17	5	0.2	0.2	0.3	0.1
325	Mongolism	118	98	12	8	0.4	0.4	0.2	0.2
560–561	Hernias	135	52	74	9	0.4	0.2	1.1	0.2
748	Clubfoot	533	361	68	104	1.6	1.6	1.0	2.3
740–749	Musculoskeletal	86	57	17	12	0.3	0.3	0.3	0.3
750	Monstrosity	318	222	32	64	0.9	1.0	0.5	1.4
751	Spina bifida, meningocele	270	204	26	40	0.8	0.9	0.4	0.9
752	Congenital hydrocephalus	310	223	43	44	0.9	1.0	0.6	1.0
753	Other nervous system	103	68	20	15	0.3	0.3	0.3	0.3
754	Circulatory system	598	399	105	94	1.8	1.8	1.6	2.1
755	Cleft palate and harelip	276	207	39	30	0.8	0.9	0.6	0.7
756	Digestive system	234	144	51	39	0.7	0.6	0.8	0.9
757	Genitourinary system	378	294	47	37	1.1	1.3	0.7	0.8
758	Bone and joint	665	226	345	94	2.0	1.0	5.2	2.1
759	Other and unspecified	900	579	190	131	2.7	2.6	2.9	2.9
	All malformations	5,152	3,290	1,119	743	15.3	14.6	16.9	16.6

ISC—International Statistical Classification.

in relationships between ethnic classes (or other variables) for various hospital groups. Presuming this, we may attach some importance to consistencies or inconsistencies in patterns of the data analyzed in this way. It still must be kept in mind, however, that numbers are very small in some of the cells of the tables and may make for spurious aberrations due to the relatively large sampling variation.

For neoplasms (exclusive of hemangiomas and lymphangiomas) there is a remarkably consistent rate of two to three per 10,000 regardless of hospital auspices or ethnic group (Table 2). The only exception is that for nonwhites in the private service of voluntary hospitals, but this rate is based on only three cases. Yet the summary data in Table 1 suggest a higher frequency among nonwhites. The gross nature of the category prohibits further analysis in view of the small numbers involved. For general information, however, it can be stated that the only large aggregations of tumors (aside from lymphangioma and hemangioma) are pilonidal cyst (16 cases) and benign melanoma of the skin (13 cases); an additional 16 cases are included under the heading of unspecified types of neoplasms of skin and musculoskeletal system and 15 in the general unspecified category.

There is a tendency for mongolism to be more frequently recorded among the whites. Hernias are consistently reported at least five times more often among nonwhites than among either whites or Puerto Ricans, a finding also noted by Ivy.[6] On the other hand, clubfoot is lowest among nonwhites and uniformly so in each hospital group. This condition is reported most often among the Puerto Ricans, also a uniform observation noted except among the few Puerto Rican deliveries on private service in the voluntary hospitals.

With the residual group of musculoskeletal defects there are no startling differentials between the groups. For monstrosities (largely anencephalics), the rate is uniformly lowest among nonwhites; this finding is in keeping with observations of some other studies but the actual frequency at delivery varies widely from study to study. However, the fact that Puerto Ricans exhibit a consistently high rate is not known to have been elsewhere noted. Another unpublished study made in New York City also suggested that women from Caribbean areas delivered anencephalic infants at a relatively high rate in comparison to other New York City residents.

With spina bifida and meningocele we find a situation similar to that for clubfoot, with low occurrence reported among nonwhites. Here, too, the rates among whites and Puerto Ricans are similar, but generally lower than for clubfoot.

Congenital hydrocephalus shows no consistent pattern. There is not only considerable variability between ethnic groups but also between hospital groups for each population segment. Still, for the combined data (Table 1), the condition seems relatively less frequent among nonwhites. However, for the remaining nervous system malformations, variability seems of little significance considering the small numbers involved, while the combined data in Table 1 show no differences between the groups.

Malformations of the circulatory system are reported more often among Puerto Ricans and this is true regardless of the source of the reports. Yet, in gross (Table 1), the differential does not appear quite as great as is apparent within each hospital type in Table 2. It is noteworthy that these rates are lowest consistently for each ethnic group in the municipal hospitals. This finding could result from less success in early identification of circulatory defects in such hospitals or from less complete recording. If this be so, then the

Table 2—Rates per 1,000 Live Birth of Congenital Malformations Reported on Vital Records by Type of Hospital, Service, and Ethnic Group: New York City, 1958 and 1959

ISC Rubric	Congenital Malformation	Voluntary Hospitals								Municipal Hospitals				Proprietary Hospitals			
		Private Service				General Service											
		Total	White	Non-white	Puerto Rican	Total	White	Non-white	Puerto Rican	Total	White	Non-white	Puerto Rican	Total	White	Non-white	Puerto Rican
228	Hemangioma, lymphangioma	0.4	0.4	1.2	—	0.5	0.6	0.5	0.6	0.3	0.2	0.4	0.3	0.7	0.7	1.4	1.3
140–239	Other neoplasms	0.2	0.2	0.5	—	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.0*	0.2	0.2	—	—
325	Mongolism	0.4	0.4	0.3	—	0.2	0.3	0.2	0.3	0.1	0.1	0.2	0.1	0.6	0.6	0.5	—
560–561	Hernias	0.3	0.3	1.4	—	0.6	0.2	1.4	0.2	0.6	0.1	1.0	0.2	0.3	0.2	1.4	—
748	Clubfoot	1.4	1.5	0.5	0.5	1.7	1.8	1.2	2.2	1.7	2.0	1.1	2.6	1.8	1.8	0.9	3.9
740–749	Musculoskeletal	0.2	0.2	0.2	—	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.2	0.3	0.3	—	—
750	Monstrosity	0.9	0.9	0.5	2.7	1.2	1.2	0.5	2.0	0.7	0.9	0.5	1.0	1.2	1.2	0.9	—
751	Spina bifida, meningocele	0.8	0.8	0.2	0.9	0.7	0.8	0.5	0.8	0.8	2.0	0.4	1.0	1.1	1.1	—	—
752	Congenital hydrocephalus	0.8	0.8	1.2	1.8	0.9	1.0	0.9	0.7	0.9	2.3	0.5	1.1	1.3	1.3	—	1.3
753	Other nervous system	0.3	0.3	0.3	0.5	0.3	0.2	0.4	0.4	0.3	—	0.3	0.3	0.3	0.3	—	—
754	Circulatory system	1.8	1.7	2.1	3.2	2.1	1.8	2.0	2.4	1.4	1.2	1.2	1.7	2.1	2.0	4.2	6.5
755	Cleft palate and harelip	0.8	0.8	0.3	0.9	0.8	0.8	0.7	0.9	0.7	1.5	0.6	0.5	1.1	1.1	—	—
756	Digestive system	0.5	0.5	0.7	0.9	0.9	0.6	1.1	1.2	0.7	1.1	0.6	0.7	0.8	0.9	0.9	—
757	Genitourinary system	1.1	1.1	0.7	1.8	1.2	1.8	0.9	0.7	0.8	1.1	0.6	0.9	1.6	1.6	1.4	—
758	Bone and joint	1.0	0.8	4.3	4.1	2.9	1.5	5.4	1.8	3.8	1.9	5.4	2.0	1.5	1.3	5.1	6.5
759	Other and unspecified	2.5	2.5	2.6	3.2	2.8	2.6	3.3	2.8	2.9	2.9	2.9	2.9	3.0	3.0	1.9	6.5
	All malformations	13.6	13.3	17.2	20.3	17.4	15.7	19.3	17.4	16.2	18.0	16.1	15.7	17.9	17.7	18.6	26.2

ISC—International Statistical Classification.
* <0.05

Puerto Rican excess in the gross rate shown in Table 1 is smaller than it should be because of the high proportion of municipal hospital deliveries among Puerto Ricans.

Cleft palate and harelip exhibit low rates among nonwhites in comparison with the other two population groups with only one exception, but numbers here are sometimes small, too. Ivy has, however, also noted such a difference.[6] For malformations of the digestive tract the pattern is inconsistent but in gross there is an upward gradient from white to nonwhite to Puerto Rican. A tendency toward lower frequency of reporting of genitourinary malformations is evident among nonwhites. On the contrary, the frequency for malformations of bones and joints is highest among nonwhites by a considerable margin, possibly because of polydactylism, which is known to occur more frequently among this group.[6,7]

Category 759, the residual group, represents such an agglomeration of anomalies that comment seems unwarranted.

Differentials by Source

The point has been made that consistency in the patterns of reported frequencies from different reporting sources might suggest epidemiologic significance in the variations. Such patterns as they relate to ethnic differences have been pointed out. Nevertheless, it seems probable that completeness and accuracy does vary according to the source of report, and some relationships may therefore be obscured. Suggestive data on this point are included in Table 3, where reported rates for selected congenital malformations among white non-Puerto Ricans only are tabulated by source of report. The anomalies have been arranged in descending order of the rates derived from reports from the municipal hospitals.

In a number of instances these rates in the municipal hospitals are higher by a considerable margin than those for whites in other hospitals. Even though the numbers are very small (in no case exceeding 20 in the municipal institutions), the rates appear excessive. At

Table 3—Rates per 1,000 Live Births of Selected Congenital Malformations Reported Among White Infants, by Hospital Auspices and Service: New York City, 1958 and 1959

ISC Rubric	Congenital Malformation	Hospital Auspices			
			Voluntary		
		Municipal	General Service	Private Service	Proprietary
752	Congenital hydrocephalus	2.3	1.0	0.8	1.3
748	Clubfoot	2.0	1.8	1.5	1.8
751	Spina bifida, meningocele	2.0	0.8	0.8	1.1
758	Bone and joint	1.9	1.5	0.8	1.3
755	Cleft palate and harelip	1.5	0.8	0.8	1.1
754	Circulatory system	1.2	1.8	1.7	2.0
756	Digestive system	1.1	0.6	0.5	0.9
757	Genitourinary system	1.1	1.8	1.1	1.6
750	Monstrosity	0.9	1.2	0.9	1.2
228	Hemangioma, lymphangioma	0.2	0.6	0.4	0.7

Table 4—Rates per 1,000 Live Births of Congenital Malformations Reported on Vital Records, by Birth Weight and Ethnic Group: New York City, 1958 and 1959

ISC Rubric	Congenital Malformation	All Deliveries			White		Nonwhite		Puerto Rican	
		Under 2,501 Grams	2,501 and Over	Not Stated	Under 2,501 Grams	2,501 and Over	Under 2,501 Grams	2,501 and Over	Under 2,501 Grams	2,501 and Over
228	Hemangioma, lymphangioma	0.3	0.5	1.4	0.2	0.5	0.4	0.5	0.1	0.4
140–239	Other neoplasms	0.5	0.2	—	0.6	0.2	0.4	0.2	—	0.1
325	Mongolism	1.0	0.3	2.1	1.4	0.4	0.3	0.1	0.1	0.1
560–561	Hernias	0.9	0.3	8.5	1.0	0.1	0.9	1.1	0.2	0.1
748	Clubfoot	2.9	1.4	5.0	3.5	1.4	1.4	0.9	4.3	2.1
740–749	Musculoskeletal	0.5	0.2	—	0.3	0.3	0.7	0.2	0.6	0.2
750	Monstrosity	4.6	0.4	45.5	6.0	0.4	1.4	0.2	6.6	0.5
751	Spina bifida, meningocele	2.2	0.6	7.8	2.8	0.7	1.1	0.3	2.4	0.7
752	Congenital hydrocephalus	2.6	0.6	24.2	3.9	0.7	1.3	0.4	1.1	0.8
753	Other nervous system	1.3	0.2	4.3	1.5	0.2	1.1	0.2	1.1	0.3
754	Circulatory system	4.5	1.5	5.0	4.8	1.5	3.0	1.3	6.6	1.6
755	Cleft palate and harelip	1.8	0.7	3.6	2.2	0.8	1.3	0.5	1.7	0.6
756	Digestive system	2.2	0.5	5.7	2.4	0.5	1.8	0.6	2.1	0.7
757	Genitourinary system	2.2	1.0	2.1	2.7	1.2	1.5	0.6	1.7	0.7
758	Bone and joint	3.6	1.8	7.8	2.3	0.9	5.6	5.1	4.1	1.8
759	Other and unspecified	8.1	2.0	19.1	9.5	2.0	6.3	2.2	6.8	2.4
	All malformations	39.0	12.3	142.1	45.1	11.6	28.4	14.5	40.4	13.1

ISC—International Statistical Classification.

the same time, the rates of reported anomalies from the other three sources are relatively close to one another.

It is quite possible, of course, that the white women utilizing municipal hospitals differ from those delivering in the institutions of other auspices. On the other hand, one would expect similarity, economically at least, between women delivered on private service of voluntary hospitals and those in proprietary hospitals and hence a similarity of rates. Instead, the rate for the private service patients is lower in every case than the corresponding rate for the proprietary hospital patients. At the same time, the rates for general service patients tend to resemble those for the women in proprietary hospitals. For some malformations, there is remarkable agreement in the rates for the two classes of patients in the voluntary hospitals.

Despite the differences in rates, however, the *rank order* of frequencies is fairly similar for the hospitals other than the municipals. The difference between the municipal hospital rates and the other rates is particularly noticeable for hydrocephalus, circulatory system anomalies, and genitourinary malformations. Both the latter categories are much lower in rank order of the rates than for the other hospital groups.

This table serves to illustrate once more how difficult it is to interpret data for congenital malformations, which not only have low frequency but are ob-

viously subject to other possibly unrecognized influences. It is easy to ascribe these variations in rates entirely to reporting practices, but their magnitude is no more than those observed in different population groups by competent investigators. The table is presented as an example of the kind of interpretive problem to be met in any kind of reporting system. It does not invalidate the original assumption made: differentials that are consistent within hospital groups deserve further investigation.

Birth Weight

It is difficult to assess the possible significance of the extraordinarily consistent higher frequency of reported malformations among infants of low birth weight (Table 4). Close to half the reported malformations (44.6 per cent) derive from fetal and infant death records among the infants of less than 2,500 grams in birth weight, while only 24.2 per cent derive from these sources among the heavier infants. This fact is probably related to the lethality of specific malformations as well as the ability to get post-mortem findings. But whether the observation means that malformed fetuses in general tend to be delivered early (or develop poorly) or simply that malformations among low weight infants are more likely to be included in this series is a moot question. It is noteworthy, however, that the excess relationship for infants under 2,500 grams exists for every listed category of malformation and for each ethnic group, except for hernias among nonwhites and for hemangiomas and lymphangiomas among each ethnic group. A

Table 5—Numbers and Rates per 1,000 Live Births of Congenital Malformations Reported on Vital Records, by Plurality: New York City, 1958 and 1959

ISC Rubric	Congenital Malformation	Numbers		Rates per 1,000 Live Births	
		Single Births	All Others	Single Births	All Others
228	Hemangioma, lymphangioma	156	2	0.5	0.3
140–239	Other neoplasms	70	—	0.2	—
325	Mongolism	115	3	0.4	0.4
560–561	Hernias	132	3	0.4	0.4
748	Clubfoot	516	17	1.6	2.3
740–749	Musculoskeletal	85	1	0.3	0.1
750	Monstrosity	298	20	0.9	2.7
751	Spina bifida, meningocele	264	6	0.8	0.8
752	Congenital hydrocephalus	295	15	0.9	2.0
753	Other nervous system	98	5	0.3	0.7
754	Circulatory system	578	20	1.8	2.7
755	Cleft palate and harelip	269	7	0.8	0.9
756	Digestive system	224	10	0.7	1.4
757	Genitourinary system	371	7	1.1	0.9
758	Bone and joint	645	20	2.0	2.7
759	Other and unspecified	870	30	2.6	4.1
	All malformations	4,986	166	15.2	22.4

ISC—International Statistical Classification.

Table 6—Numbers and Rates per 1,000 Live Births of Congenital Malformations Reported on Vital Records, by Parity: New York City, 1958 and 1959

ISC Rubric	Congenital Malformation	Numbers			Rates per 1,000 Live Births		
		Para 1	Para 2 or More	Not Stated	Para 1	Para 2 or More	Not Stated
228	Hemangioma, lymphangioma	41	117	—	0.4	0.5	—
140–239	Other neoplasms	25	45	—	0.2	0.2	—
325	Mongolism	31	87	—	0.3	0.4	—
560–561	Hernias	36	99	—	0.4	0.4	—
748	Clubfoot	204	328	1	2.0	1.4	7.8
740–749	Musculoskeletal	31	55	—	0.3	0.2	—
750	Monstrosity	97	214	7	1.0	0.9	54.7
751	Spina bifida, meningocele	86	181	3	0.9	0.8	23.4
752	Congenital hydrocephalus	113	191	6	1.1	0.8	46.9
753	Other nervous system	31	70	2	0.3	0.3	15.6
754	Circulatory system	163	434	1	1.6	1.8	7.8
755	Cleft palate and harelip	93	183	—	0.9	0.8	—
756	Digestive system	62	171	1	0.6	0.7	7.8
757	Genitourinary system	123	255	—	1.2	1.1	—
758	Bone and joint	191	474	—	1.9	2.0	—
759	Other and unspecified	279	619	2	2.8	2.6	15.6
	All malformations	1,606	3,523	23	16.5	15.0	179.7

ISC—International Statistical Classification.

generally higher incidence of congenitally determined defects in premature infants than in mature infants has also been noted by Miller[7] and in the British Columbia series.[2]

The rates for infants of unreported birth weight are in most instances even higher than those for infants less than 2,500 grams at birth. This observation is of little consequence, since the numbers involved are very small usually, even for the total group for which the rates are shown. It is in general a function of the poor reporting of birth weight for fetal deaths, although some contribution is made by an apparent lesser likelihood, that an infant who dies will be weighed than one who survives. In this series, birth weight was not reported for 1.4 per cent of surviving infants, for 2.2 per cent of infants who died, but for 27.6 per cent of the fetal deaths.

Plurality

Reported frequency of malformations is generally higher among plural births than among single-born infants, as seen in Table 5. Notable exceptions are mongolism, hernias, spina bifida and meningocele, and genitourinary anomalies. It seems improbable that malformations are simply more likely to be reported for multiple births. Is it possible that twinning itself represents an aberration that carries with it a higher risk of other aberrations in development of the embryo or that the cause of a split of the zygote may also sometimes

be the cause of malformations in the resulting infants?

Parity

Parity here (Table 6) means the total number of pregnancies and should perhaps be termed "gravidity." Because of the small numbers, only two classes were used. With this simple dichotomy, it is impossible to say in general that there is much difference in the frequency of reported malformations among first born and later infants. There is a difference in favor of later births for mongolism, as would be expected, since mongols are said to occur more often among older mothers and parity is related to age of mother also, but the difference is not statistically significant. The greatest differential occurs for clubfoot, where the rate is significantly higher among first births. Other differences are not statistically significant.

Here also the number of cases with unreported parity are few and their effects slight even though the tabulated rates are conspicuously high.

Table 7—Rates per 1,000 Live Births of Congenital Malformations Reported on Vital Records by Age of Mother and Ethnic Group: New York City, 1958 and 1959

ISC Rubric	Congenital Malformation	Age in Years: All Ethnic Groups −20	20–24	25–29	30–34	35–39	40+	White −20	20–24	25–29	30–34	35–39	40+
228	Hemangioma, lymphangioma	0.3	0.4	0.6	0.5	0.4	0.4	0.3	0.4	0.6	0.5	0.3	0.4
140–239	Other neoplasms	0.3	0.2	0.2	0.2	0.1	—	0.3	0.2	0.2	0.3	—	—
325	Mongolism	0.1	0.2	0.3	0.3	0.8	2.9	0.2	0.3	0.3	0.2	0.9	3.5
560–561	Hernias	0.5	0.5	0.4	0.3	0.3	0.3	0.2	0.2	0.3	0.1	0.3	0.4
748	Clubfoot	1.6	1.8	1.5	1.4	1.4	1.7	1.5	1.8	1.5	1.4	1.6	2.0
740–749	Musculoskeletal	0.2	0.3	0.3	0.3	0.1	0.3	0.4	0.3	0.2	0.2	0.1	0.4
750	Monstrosity	0.9	0.8	0.9	1.3	0.9	0.4	1.0	0.8	0.9	1.4	1.0	0.4
751	Spina bifida, meningocele	0.4	0.7	0.9	0.8	1.2	1.1	0.3	0.7	1.0	1.0	1.2	1.3
752	Congenital hydrocephalus	0.9	0.8	0.7	1.1	1.5	1.0	1.2	0.9	0.7	1.3	1.6	1.1
753	Other nervous system	0.2	0.3	0.3	0.3	0.5	0.6	0.3	0.2	0.3	0.3	0.5	0.6
754	Circulatory system	1.5	1.6	1.8	1.6	2.1	4.6	1.0	1.6	1.9	1.5	2.0	4.1
755	Cleft palate and harelip	1.0	0.8	0.7	0.8	1.0	1.4	1.3	1.0	0.7	0.9	1.1	1.9
756	Digestive system	0.6	0.8	0.7	0.7	0.6	1.3	0.7	0.6	0.5	0.7	0.6	1.5
757	Genitourinary system	0.8	1.1	1.2	1.0	1.3	1.9	1.0	1.3	1.4	1.1	1.4	2.2
758	Bone and joint	2.8	2.0	1.9	1.8	2.0	1.4	1.1	0.9	1.0	1.0	1.1	1.3
759	Other and unspecified	2.9	2.6	2.4	3.0	2.9	4.6	2.8	2.4	2.1	3.1	2.8	5.2
	All malformations	15.2	14.8	14.7	15.4	17.2	23.8	13.8	13.9	13.7	15.0	16.4	26.2

ISC Rubric	Congenital Malformation	Age in Years: Nonwhite −20	20–24	25–29	30–34	35–39	40+	Puerto Rican −20	20–24	25–29	30–34	35–39	40+
228	Hemangioma, lymphangioma	0.3	0.3	0.7	0.5	1.2	0.9	0.3	0.5	0.2	0.7	0.4	—
140–239	Other neoplasms	0.5	0.3	0.2	0.1	0.4	—	—	0.1	0.2	—	0.4	—
325	Mongolism	0.1	—	0.2	0.4	0.2	0.9	0.2	0.1	0.1	0.2	0.7	1.4
560–561	Hernias	1.0	1.4	1.2	0.8	0.8	—	0.2	0.3	0.2	—	—	—
748	Clubfoot	1.8	0.8	1.1	0.7	1.2	—	1.7	2.7	2.3	2.5	1.1	1.4
740–749	Musculoskeletal	0.1	0.3	0.5	0.2	—	—	0.2	0.2	0.1	0.8	0.7	—
750	Monstrosity	0.5	0.5	0.6	0.6	—	—	1.4	1.3	1.5	2.0	1.1	1.4
751	Spina bifida, meningocele	0.4	0.4	0.3	0.3	0.8	—	0.6	0.7	1.1	0.8	1.8	1.4
752	Congenital hydrocephalus	0.7	0.6	0.7	0.6	1.2	—	0.6	0.9	1.2	1.2	1.1	1.4
753	Other nervous system	0.2	0.4	0.2	0.2	0.4	0.9	0.3	0.3	0.4	0.2	1.1	—
754	Circulatory system	1.3	1.1	1.6	2.2	2.1	4.5	2.6	2.2	1.5	1.2	3.3	8.6
755	Cleft palate and harelip	0.8	0.5	0.6	0.4	1.2	—	0.9	0.7	0.7	0.7	—	—
756	Digestive system	0.3	1.0	0.9	0.7	0.4	0.9	0.9	0.9	1.1	0.7	0.7	—
757	Genitourinary system	0.4	0.7	0.7	0.7	1.4	1.8	1.2	1.1	0.4	0.7	0.4	—
758	Bone and joint	5.0	5.2	5.5	5.3	5.4	1.8	2.1	2.1	2.1	1.2	3.3	1.4
759	Other and unspecified	3.3	2.5	3.3	2.5	3.2	1.8	1.2	3.0	2.8	3.4	3.6	4.3
	All malformations	16.6	16.0	18.2	16.1	19.6	13.6	15.1	16.9	15.9	16.6	19.6	21.5

ISC—International Statistical Classification.

Table 8—Numbers and Rates per 1,000 Live Births of Congenital Malformations Reported on Vital Records With and Without Selected Maternal Medical Conditions also Reported: New York City, 1958 and 1959

Medical Condition in Mother	Number of Congenital Malformations Reported		Rate per 1,000 Total Deliveries*	
	With Specified Condition	Without Specified Condition	With Specified Condition	Without Specified Condition
All conditions	767	4,385	21.97†	14.16
Diabetes	71	5,081	82.65†	14.78
Pyelitis	31	5,121	42.06†	14.90
Preeclampsia	130	5,022	23.30†	14.82
Syphilis	21	5,131	17.62	14.94
Heart disease	26	5,126	17.03	14.94
Hypertensive disease	30	5,122	16.84	14.94
Uterine bleeding not associated with labor	102	5.050	16.31	14.93

* Live births plus fetal deaths of 20 weeks or more gestation.
† Difference is significant at <0.01.

Age of Mother

In general, malformations are reported more frequently among infants of older mothers, regardless of ethnic group, as indicated in the last line of Table 7. The exceptions are clubfoot, anomalies of bones and joints, and hernias. For the last, which includes omphalocele, there is some suggestion of higher frequency at young maternal age among the nonwhite group. Cleft palate and harelip seem to be concentrated at both ends of the maternal age scale, the hazard being less among infants of women 25-34 years of age; this pattern is most noticeable among whites, the numbers in the other groups being small. The known higher frequency of mongolism with advancing maternal age is also seen here.

Influence of Maternal Conditions

The existence of an item on the New York City vital records relating to medical conditions in the mother during pregnancy suggested review of the frequency of malformations among infants of mothers with reported complications. The information on reported complications comes from a check-off item on the birth and fetal death certificates asking for conditions present during pregnancy and listing the following:

Preeclampsia
Eclampsia
Hypertensive disease
Uterine bleeding not associated with labor
Pyelitis
Nephritis
Heart disease
Diabetes
Syphilis
Tuberculosis
German measles or other viral infection: (specific disease to be specified) 1st trimester, 2nd trimester, 3rd trimester, trimester not reported
Injury or operation
Benign or malignant neoplasm
Other (specify)

Grossly, congenital malformations are reported half again as frequently in association with complications of pregnancy as without such complications.

Among the 309,624 deliveries, without mention of a coexisting medical condition in the mother, there were 4,385 congenital malformations reported for a rate of 14.2 per 1,000 such deliveries. Among the 34,918 with complications, there were 767 malformed infants reported, giving a rate of 22.0. The difference between these rates is highly significant statistically. The import one wishes to attach to it depends upon the weight one chooses to give to possible biases producing this result. It is noteworthy, however, that in the British Columbia series covering only liveborn infants, abnormalities were reported two and a half times more frequently among infants of mothers with complications of pregnancy than among those without such complications.[2]

There are only a few specific conditions that were associated with malformations in more than 15 cases in this series. The malformation rates for infants with these conditions are shown in Table 8. For only three of the conditions are statistically significant differences found relative to the rate for pregnancies without the specific condition: diabetes, pyelitis, and preeclampsia. In each of these cases, the probability of such a difference is less than 0.01.

What types of malformations are associated with these conditions? With diabetes are found:

Monstrosity	14
Bone and joint	6
Circulatory	5
Other nervous system	4
Spina bifida	3
Digestive system	3
Congenital hydrocephalus	2
Genitourinary system	2
Hernia	2
Neoplasms	1
Cleft palate-harelip	1
Other and unspecified	28

It is noteworthy that 23 of the 71 anomalies relate to the central nervous system.

Among the 31 malformations associated with pyelitis are found:

Bone and joint	7
Clubfoot	5
Mongolism	3
Monstrosity	2
Congenital hydrocephalus	2
Cleft palate-harelip	2
Neoplasms (including 2 hemangioma or lymphangioma)	3
Musculoskeletal	1
Circulatory system	1
Other and unspecified	5

A considerably larger number of malformations (130) are associated with preeclampsia:

Bone and joint	23
Genitourinary	16
Congenital hydrocephalus	10
Clubfoot	9
Cleft palate-harelip	9
Spina bifida	8
Neoplasms (of which 5 are hemangioma or lymphangioma)	8
Other nervous system	4
Circulatory system	4
Monstrosity	3
Digestive system	3
Hernias	2
Other and unspecified	31

The clinicians and geneticists may want to supply interpretations. An association of congenital abnormalities with maternal diabetes has been affirmed by some authors[8-12] and also questioned[13] on the grounds of the lack of comparability of studies and of the possible influence on the observed association of high mortality among infants of diabetic mothers. It is difficult to see how either of these factors could produce the result shown in this New York City series. With respect to any association of maternal pyelitis or toxemia with congenital malformations, little appears in the literature. Hoet[12] indicates there is question whether toxemia can be implicated, but a large proportion of the malformations found associated in the British Columbia series[2] with maternal

complications were jointly reported with toxemia of pregnancy. No similar data regarding pyelitis can be cited, but various authors suggest that altered maternal functions may be involved in teratogenesis.[8,9] Rummel introduces in addition the idea that antibiotics that tend to cumulate in the fetal organism may represent a teratogenic danger.[14] Could such treatment of pyelitis early in pregnancy be the factor rather than the condition itself?

A few examples on another axis of analysis may serve to emphasize these observations. The over-all reported incidence of clubfoot is 1.6 per 1,000; but among infants of women reported as having pyelitis the rate is 6.8. With monstrosity, crude incidence is 0.9, but for diabetic mothers 16.3 per 1,000 is the rate. Again, for diabetic mothers, the incidence of spina bifida and meningocele is 3.5 per 1,000 among their infants compared to 0.8 generally. Congenital hydrocephalus was reported twice as frequently (1.8 per 1,000) in association with preeclampsia as in general. These differences between reported joint incidence of selected malformation with specified complications of pregnancy and the incidence without complications are highly significant statistically (P is less than 0.001).

Comment seems indicated on two of the listed conditions with relatively low malformation rates: heart disease and uterine bleeding not associated with labor. It may be that seriously incapacitating heart disease is eliminated as a factor by therapeutic or spontaneous abortion in some cases and by supportive therapy in others. Further speculation must again be left to the clinicians.

Uterine bleeding not associated with labor is obviously not a clinical entity but a symptom. What it represents as reported on birth and fetal death certificates is anybody's guess, especially since the stage of pregnancy when bleeding occurred is not known; there have been cases mentioning bleeding at the sixth week and others at the eighth month. All that we can infer from the data as presently collected and coded is that something happened during pregnancy that the physician deemed worthy of noting. Is it possible that such bleeding was indicative of maternal disturbance of unknown character that, at least in some cases, affected the fetus? Or is this simply a situation where the existence of the malformation led to recording of a bleeding episode that would otherwise be ignored? One may also conjecture that some pregnancies in which bleeding occurred early in pregnancy (perhaps coincidentally with failure of proper embryologic development) resulted in abortion. Such cases could not appear in a series such as we have here and this eventuality could be a factor in the relatively low rate for bleeding episodes among pregnancies producing malformed infants close to term. If we could segregate those cases where the bleeding episode was early in pregnancy we might find a different story for such cases.

We must recognize in all these discussions, and here as much as anywhere, that most of the malformation categories are conglomerations of individual anomalies, probably of different etiologies. Specific malformations within a category may be influenced by maternal changes or imbalances due to existing disease while others in the same category are not. Similarly, some complications may produce different anomalies, depending upon the stage at which they occur. It is impossible to demonstrate from this source speculations of this kind. If, however, we can be convinced that there is no artifact in the data and that any reporting failures do not seriously bias the findings, certainly a productive area for research is indicated by these observations.

Summary by Type of Malformation

Perhaps the data in these tables will become more intelligible if we summarize the variations noted in terms of the major malformation groups rather than the factors of analysis.

Hemangioma and lymphangioma—No identifiable relationships are observed for any of the variables here inspected. These conditions are more frequently reported among infants of more than 2,500 grams birth weight, but this result may be due to simple disinclination to report them for fetal deaths or for moribund infants.

Other neoplasms—The only apparent relationship is with young age of mother, and this does not seem to be strong.

Mongolism—Low birth weight and advanced age of mother show differentials here. Three of the 118 cases were associated with pyelitis in the mother.

Hernia—A clearly higher frequency among nonwhites exists with some indication that young maternal age may be a factor. Low birth weight seems to be involved, but not among the nonwhites.

Clubfoot—Relatively low frequencies among nonwhites, higher rates at low birth weights, and among multiple births are characteristics observed with this anomaly. Five of the 533 cases were associated with pyelitis in the mother.

Monstrosity—This condition showed high rates among Puerto Ricans, at low birth weights, and among multiple births. Fourteen of the 318 cases were reported among diabetic mothers, three among preeclamptics and two among those with pyelitis. In four other cases nephritis was mentioned and in ten, antepartum bleeding.

Spina bifida and meningocele—Low rates are found among nonwhites and among prematures. Advanced age of mother may be a factor. Eight of the 270 cases were reported in preeclamptic pregnancies and three with diabetic mothers.

Congenital hydrocephalus—Low birth weight and multiple births are the only two factors showing any marked association with this condition. However, there is some indication that advancing age of mother may be of influence, also. Ten of the 310 cases occurred among infants of preeclamptic mothers, two each among those of mothers with diabetes and pyelitis. In four additional cases hypertensive disease was mentioned, and antepartum bleeding in seven others.

Circulatory system anomalies—Here again, birth weight and plurality show an association with the conditions encompassed in this group while rates are also higher at older maternal ages. Five of the 598 cases were associated with maternal diabetes, four with preeclampsia and one with pyelitis.

Cleft palate and harelip—Rates for these conditions are highest at each end of the maternal age scale. A relationship with birth weight is also indicated. The mothers of nine of the 276 infants were preeclamptic, two had pyelitis, and one diabetes. For 11 others antepartum bleeding had been reported.

Digestive system malformations — Highest rates of reported malformations of the digestive system occur at maternal ages of 40 or more. This is distinctly so among whites, but does not hold for other ethnic groups. The numbers are small for reliable conclusions, but three of the 234 did involve preeclampsia and three maternal diabetes.

Genitourinary anomalies—Advanced age of mother appears to be implicated here, but again numbers tend to get small, especially when data are subdivided by ethnic group. Low birth weight infants are reported more frequently to have such malformations than those of more than 2,500 grams, while in 16 of the 378 cases, the mother was preeclamptic. In seven others antepartum bleeding was reported.

Malformations of bones and joints—

Malformations of bones and joints are reported twice as frequently among Puerto Ricans as among continental whites, and more than twice as frequently among nonwhites as among Puerto Ricans. These anomalies are also more frequent among prematures and among plural births. Of the 665 reported cases seven occurred among pregnancies complicated by pyelitis, six among those complicated by diabetes, and 23 times with preeclampsia.

Discussion

Even with 336,000 deliveries we find ourselves impeded in attempting to analyze the occurrence of congenital malformations according to the usual common variables available from vital records. The two horns of the dilemma are sharp. If we try to be specific as to the malformation (which appears to be the only way to have confidence that relationships are meaningful), the numbers become too small for extensive breakdowns by other factors of analysis. Relationships may hence be obscured. If malformations are considered in groups, to provide adequate numbers, relationships noted with other variables are questionable in interpretation.

The dilemma is compounded by doubts as to the validity of the basic information. Yet in many instances observed relationships hold for several different population groups, which suggests the relationships may be meaningful because interfering biases due to diagnostic and reporting deficiencies together would not consistently affect only the same subgroups of the population.

Despite the acknowledged limitations of the data from New York City's vital records relative to congenital malformation it seems worth pointing out a few particular observations emphasizing that no special program has existed to stimulate reporting of congenital malformations on these records in the city.

1. The city rates are well within the ranges for incidence reported from other studies for comparable malformations. These malformations include anencephaly, spina bifida and meningocele, hydrocephaly, clubfoot, and mongolism.[3]

2. The relationships between rates for whites and nonwhites are in the same direction as those for the Presbyterian Hospital series, except for hydrocephaly.[15]

3. The similarity of maternal age patterns for mongolism in the New York City data with those from other studies has been pointed out; other similarities to known variation have been mentioned.

4. The higher risk of malformations found among infants of diabetic mothers is consistent with that of other studies.

The use of birth certificates as the vehicle for collection of prenatal information for analytic purposes has often been the object of what can be most charitably termed amused tolerance. Research showing failures to report correctly, or at all, information on the corresponding hospital record has been taken as proving the uselessness of these records. At the same time, so called "overreporting" (that is, the appearance on the birth record of information that does not appear on the hospital record) has served mirabile dictu as an additional indictment. No thought seems to be given to the fact that most hospital-based studies are made from the existing charts, even though it is acknowledged that the recording in hospitals is deficient. Yet I have heard a director of an Obstetrical Service, basing his conclusions on clinical impressions and study of charts in his own hospital, disagree with the data from vital statistics with the simple remark that the only thing such statistics showed was the shortcomings of the birth certificates.

No such remark settles an issue of fact. It is quite possible that in some respects the information on the birth certificates is superior to that on the hospital chart, simply because specific questions appear that elicit from the attending physician information that he

does not trouble to record on the chart in the hospital. Published hospital series, moreover, often are subject to criticism because of lack of definitions, lack of comparative information about "normal" (i.e., control) groups and possible biases because of selection factors in the hospital populations.

In the past few years interest in vital statistics as a source of data has seen a resurgence. Advocates of other processes for collecting data have been somewhat disillusioned to find that these methods also have their limitations. More and more, research studies are again turning to the vital statistics offices for assistance.

The observations gleaned from the existing imperfect system hardly represent the actuality. However, this imperfect system produces, where it can be checked, findings usually compatible with those of studies done under careful and assiduous supervision. The reversed findings in white-nonwhite relationship of rates for hydrocephaly from the vital statistics data and from the Presbyterian Hospital series represent the only major disagrement in the comments noted above, aside from the generally lower rates for the city data which may indicate underreporting, underrecording, or failure to recognize malformations within a brief period after birth. There is no bland rationale for this disagreement.

No productive purpose is served by indictment of one method of ascertainment over another. Gross studies as well as refined and meticulous ones are essential in our present state of ignorance. It would be helpful and productive for medical science and investigation if the directors of Obstetrical Services were to insist that their staffs complete records (both registration records and hospital charts) completely and accurately. A careless attitude toward routine vital records only encourages and instills a similar attitude toward other records, including those in the hospital upon which most physicians place reliance and faith. As for the vital records, they are certainly subjected to critical evaluation; specific suggestions how the data on congenital malformation could be improved have been made.[16] In an earlier paper (J.A.M.A. 168:167, Sept. 13, 1958) the remark was made:

> ". . . in some way, the physician must be influenced to change his attitude that the death certificate is "just paper work", that its completion is a last rite for someone no longer of clinical interest, that it represents merely another bit of bureaucratic red tape. The vital statistics office in any locality has proved to be for many physicians one vast 'record room' where they have been able to obtain community-wide information for epidemiologic research in such widely separated areas as amaurotic family idiocy (Tay-Sachs disease) and leukemia. The same source is tapped for end-results of specific therapy for cancer and of surgical or other treatment of many additional diseases. The major users of information on death certificates are physicians, not alone those in public health, but research clinicians, pathologists, and practicing physicians with special interests. The attending physician, therefore, in completing the death certificate, is fundamentally transmitting information to his colleagues. His respect for them should be adequate incentive to do the job right."

The same reasoning applies here. With good will, resourcefulness, devotion and concerted efforts, with adequate funds, with the cooperation of physicians, with proper maintenance of hospital records, with adequate and accurate completion of source documents, with interested clinicians, pathologists, geneticists, epidemiologists and biostatisticians supporting the program, and with a change of attitude toward vital statistics as a source of information, a sensitive surveillance system and a useful source for epidemiological studies in the area of congenital malformations can be established by means of these medical reports of deliveries filed with health agencies.

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The World Health Organization will provide to United States health workers in 1965 a limited number of short-term fellowships for the "improvement and expansion of health services" in the United States.

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A fellowship award will cover per diem and transportation and, except in very unusual circumstances, will be limited to short-term travel programs, i.e., two to four months. Employers of successful applicants will be expected to endorse applications and to continue salary during the fellowship.

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