The Underregistration of Neonatal Deaths: Georgia 1974–77

BRIAN J. MCCARTHY, MD, JULES TERRY, MD, MPH, ROGER W. ROCHAT, MD, SETH QUAVE, AND CARL W. TYLER, JR., MD

Abstract: We reviewed the neonatal outcome of 3,369 infants who weighed less than or equal to 1500 grams and who were born in Georgia during the years 1974–1976. We matched 1,465 of these infants with a death certificate registered in the State's Vital Records. Upon review of the hospital records of the remaining infants, we identified 453 infants that died during the neonatal period without a death certificate being registered.

Subsequently, we compared the hospital death registries for 1977 in Georgia and death certificates registered in Vital Records during 1977. We identified an additional 236 infants who died without a death certificate being registered. Forty per cent of these infants weighed greater than 1500 grams.

Two major procedural errors regarding the filing of death certificates in Georgia at the local level contributed to this 21 per cent underregistration of neonatal deaths in 1974–1977. The underregistration occurred disproportionately for rural areas, for unmarried mothers, and for Black infants. The reason for underregistration included failure of hospitals and morticians to file death certificates with the county registrars. (*Am J Public Health* 1980; 70:977–982.)

Introduction

In October 1976, the State Vital Records Division began linking infant birth and death certificates in an effort to identify the maternal and infant characteristics associated with the highest risks of death. We found weight-specific neonatal mortality rates in Georgia in 1974–1976 to be surprisingly low compared with the published weight-specific mortality rates for the United States in 1960[1] and New York City (NYC) in 1968[2] (Table 1). We applied the NYC weight-specific rates to the number of infants born in Georgia in 1974–1976 weighing ≤ 1500 grams, very low-birth-weight infants (VLBW); we estimated 450–600 neonatal deaths were apparently never registered with the Office of Vital Statistics.

The suspected underregistration could have stemmed from:

- procedural errors occurred in processing birth and death certificates, particularly in transferring birth weights from the delivery room log to birth certificates and/or from birth certificates to the computer tape;
- failure to register some infant deaths at all.

This report is a four-part study designed to test these two hypotheses and determine why such underregistration occurred if it did. The preliminary results of the first report were published in the Center for Disease Control's *Morbidity and Mortality Weekly Report*[1] in order to quickly alert state and other health authorities of the urgent need to evaluate the quality of infant mortality data.

Evaluation of Coding and Procedural Errors in Registration

The first hypothesis was that the infant mortality rate was low because errors occurred in the processing of birth and/or death certificates, thus understating the number of deaths in comparison with the number of births of VLBW infants, or both.

Deaths

We first manually reviewed all 127,706 death certificates for 1974–1976 to identify those of resident infants who were born and died in Georgia within the first year of life in that three-year period. We then compared the death certificates of infants thus identified with a similarly sequenced computer list of deaths. This was to exclude the possibility that infants might have been tabulated with older age groups through a computer coding error, or that deaths of older persons were tabulated with infant deaths.

In the hand search we found 4,148 infant-death certificates but missed 26 infant deaths found on the computer list, and the computer listing identified 4,168 but missed six found in the hand search, for a total of 4,174 infant deaths (see

Address reprint requests to Family Planning Evaluation Division, Bureau of Epidemiology, Center for Disease Control, Atlanta, GA 30333. Dr. McCarthy is Medical Epidemiologist, Dr. Rochat is Deputy Director, and Dr. Tyler is Director of the Family Planning Evaluation Division, CDC Dr. Terry is Director, Family Health Unit, Division of Physical Health, Department of Human Resources, Atlanta, and Mr. Quave is Research Associate, DHR Atlanta. This paper, submitted to the Journal September 11, 1979, was revised and accepted for publication April 8, 1980.

Editor's Note: See also related editorial, p. 944, and articles, pp. 964 and 974, this issue.

TABLE 1—Comparison of Reported Weight-Specific Neonatal Mortality Rates (NMR), USA (1960),[1] New York (1968),[2] Georgia 1974–1976

Weight Group (grams)	Neonatal Mortality Rate*		
	USA (1960)	NYC (1968)	GA (1974–1976)
≤1000†	919.3	847.2	549.0
1001–1500†	548.5	379.0	243.8
1501–2000	206.6	131.0	74.7
2001–2500	58.5	34.0	18.0
>2500	5.5	8.4	2.9
Unknown	—	—	51.6
OVERALL	18.4	16.7	13.7

*Number of infants who died at <28 days of age per 1,000 live births
†Very Low-birth-Weight (VLBW)

Figure 1, Section A). We found that all six of the infant death certificates missing from the computer tape had been filed after the deadline for the statistical tape had passed. All death certificates filed for computerization before the deadline had been processed into the computer file.

The routine procedure for linking birth and death certificate of Georgia residents was to compare reported deaths with birth certificates for father's name, child's name, date of child's birth, county of residence, and race. If the father's name was unavailable, the mother's name was used*. For reported deaths not linked to births in this routine procedure, we used a variety of procedures including follow-back to the hospital where the child died to identify the birth certificate. Linkages difficult to identify were most often caused by differences or changes in names. Of 4,174 deaths, we matched 3,870 with a birth certificate and 304 were unmatched.

Births

Since infants weighing ≤ 1500 grams have by far the highest mortality rate, and the Georgia neonatal mortality rate was apparently so low for this weight group, we evaluated the accuracy of the coding of recorded birth weights of ≤ 1500 grams. In January 1973, Georgia began using a new birth certificate with a new method of recording birth weights. The weight could be recorded on the birth certificate in pounds and ounces or in grams in a four-digit box, and the measurement system (English or Metric) determined by an additional entry. Hence the number 0805 could be read by the key punch operator into the computer as 8 pounds 5 ounces or 805 grams, depending on which measurement system was used. To determine if the number of VLBW infants born had been inflated falsely, we compared the computer listing for 1974–1976 of all live-born infants weighing ≤ 1500 grams with the microfilm copy of each corresponding birth

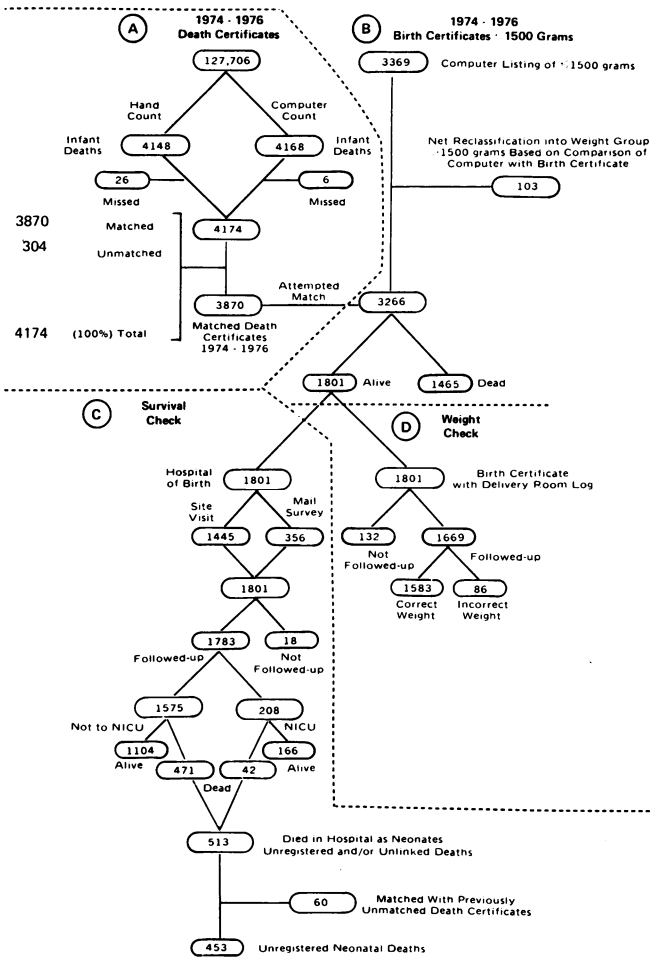

FIGURE 1—Schematic Diagram of Methodology for Investigation of Unregistered Neonatal Deaths, Georgia, 1974–1976.

certificate. This identified coding errors resulting in a normal-birth-weight infant's being incorrectly coded as a VLBW infant. We made no attempt to identify VLBW infants coded incorrectly in higher birth-weight categories. Of the 3,369 births shown on the computer tape of live-born infants weighing ≤ 1500 grams, 103 were misclassified in low-birth-weight groups, and we recoded them in higher weight groups (see Figure 1, Section B), leaving 3,266 birth records of infants weighing ≤ 1500 grams. By comparing birth certificate numbers, we then identified those infants for whom a death certificate had been matched. Of the 3,266 infants who weighed ≤ 1500 grams on their birth certificates, 1,465 (45 per cent) had a matching death certificate filed within one year after birth; 1,801 did not (Figure 1, Section B).

Evaluation of Underreregistration

Survival Follow-up

We followed up these 1,801 presumably surviving infants by a review of their neonatal hospital records, grouping

*Minor discrepancies between the birth and death certificates may have occurred (i.e., the birth date varied by one day, or the race was different) during the match. Such discrepancies were noted and further follow-up carried out to assure that an appropriate match had been made.

these births by hospital of occurrence. Of 139 hospitals, 49 had 10 or more births that were in the study group, and 90 hospitals had fewer than 10. We visited 47 of the 49 hospitals with 10 or more births; the other two hospitals did their own search according to our instructions. The 90 hospitals with fewer than 10 births were also requested to perform the same search. All of the 139 neonatal hospital's records were reviewed for the following information on each infant: if discharged, in what condition; if transferred, to what hospital; if deceased, at what age death occurred.

We found and reviewed 1,783 of the 1,801 hospital birth records that did not have a matched death certificate: 1,445 (80 per cent) by site visit and 356 (20 per cent) by mail survey (this included follow-up of 208 infants who were transferred to neonatal intensive care units). We were unable to locate 18 of the 1,801 infants.

We found that 513 (29 per cent) of these infants had died in a hospital during the neonatal period. We made no effort to determine whether an infant had died after leaving the hospital. All the deaths were to live-born infants according to hospital records,** and the age at death ranged from five minutes to 21 days. By comparing the birth certificate of the 513 deceased infants with previously unmatched death certificates (304), we were able to match an additional 60 previously unmatched death certificates; the remaining 244 unmatched death certificates were not among the unregistered infant deaths after careful hand comparison of the two groups. The 453 unregistered VLBW neonatal deaths represented 14 per cent of all neonatal deaths in this three-year period 1974–1976 (see Figure 1, Section C).

Birth Weight Follow-up

For these 1,801 births, we verified birth weights (delivery room log vs birth certificate) of 1,669 infants. Birth weights of the other 132 were not obtained because of a procedural error in one metropolitan hospital. Eighty-six, or 5 per cent, of those followed up had a higher birth weight recorded in the delivery room log than on the birth certificate (see Figure 1, Section D). Nine of the deceased infants weighed > 1500 grams at birth. Thus, 444 neonatal deaths of infants born weighing ≤ 1500 grams were recorded in the hospital record but no vital record was registered. This represents 25 per cent of the deaths in this weight group in the three-year period that should have been registered.

In order to examine the impact of these deaths on the epidemiology of neonatal mortality in Georgia, we analyzed rates for specific variables (Table 2). The weight-specific neonatal mortality rate for the 500-gram to 1000-gram weight groups was affected differently by the corrections for infants of different race, and mother's marital status, maternal age, and residence. The ratio of corrected-to-initially-reported neonatal deaths for the ≤ 1500 gram weight group shows that there was greater underregistration of infant deaths for blacks than whites, mothers under age 30, women in rural areas, and infants born out-of-wedlock. Although corrections were based upon ≤ 1500 gram weight infants only, later investigation indicated that this would not appear to have influenced results (see below and Table 3).

Underregistration in 1977

The first part of the investigation dealt with only infants weighing ≤ 1500 grams born to Georgia residents in Georgia. Since we had identified unregistered dead infants weighing > 1500, we suspected that heavier infants who died might also have been unregistered. To identify the percentage of unregistered deaths of infants by weight group, we undertook an additional investigation in April 1978. We reported our preliminary findings to all hospitals contacted during the first investigation and asked each hospital administrator to identify all infant deaths in the hospital in 1977. The line-listing of infant deaths from each hospital was compared with the death certificates filed with the State Registry for 1977 (certificates were entered if received before March 31, 1978). If we found an infant on the hospital line-listing and not in the registry, the infant's death was recognized as unregistered, and we notified the hospital that a death certificate needed to be filed (prior to July 1, 1978). We made no effort to find out why the death certificate had not been filed.

We identified 218 infants who had died following live birth in 1977 and had not had a death certificate filed. Of these, 151 (68 per cent) had a death certificate filed before July 1, 1978 as a result of our investigation, and were matched with a birth certificate; 16 (7 per cent) had a death certificate filed, but could not be matched with a birth certificate; 25 (11 per cent) did not have a death certificate filed by July 1, 1978, but could be matched with a birth certificate; 26 (12 per cent) did not have a death dertificate filed and could not be matched with a birth certificate. An additional 18 infants who had not been on any original hospital list had death certificates filed, which we then matched with birth certificates; hospital personnel identified these infants after recognizing the procedural errors that lead to the underregistration.*** Of 1,401 infant deaths in 1977, 236 (17 per cent) would have gone unregistered if this investigation had not taken place. As of July 1, 1978, 185 of 236 infants had a death certificate filed, and 198 had birth certificate information available for review.

We compared variables for the 1974–1976 investigation with the 1977 investigation (Table 3). The most important finding is that 40 per cent of unregistered deaths in 1977 were of neonates whose birth weights were > 1500 grams. Race, sex, residence, and mother's marital status were similar for both groups. When only infants who weighed ≤ 1500 grams in 1977 are considered, there was no difference between the 1974–1976 group and the 1977 group in the maternal age structure. There were two postneonatal deaths reported as neonatal deaths in the 1977 review and none in the review for 1974–1976. We assumed that since there was no difference in

**We took particular care to establish from the hospital records that a live birth occurred. We did not compare the unregistered deaths with the fetal death certificate because more than 50 per cent of the fetal death certificates in Georgia have no name registered.

***These 18 infants would not have had a certificate registered if our investigation had not prompted a review of their records. We therefore have included them in the unregistered group.

TABLE 2—Reported and Corrected* Neonatal Mortality Rates by Selected Characteristics, Georgia Residents,[1] 1974–1976

Characteristics	(Before This Study) Births	Deaths	NMR[2]	(Incorporating Study Findings) Births	Deaths	NMR[2]	Ratio[3]
TOTAL	240,401	2,839	11.8	240,401	3,292	13.7	1.16
Birth Weight*							
0-500	295	146	495.0	261	228	873.6	1.76
501-1000	1,273	715	562.0	1,216	949	780.4	1.39
1001-1500	1,801	439	243.8	1,789	567	317.0	1.30
1501-2000	4,161	311	74.7	4,161	319	76.6	1.03
2001-2500	13,347	240	18.0	13,347	241	18.0	1.00
>2500	212,512	626	2.9	212,615	626	2.9	1.00
Unknown[4]	7,012	362	51.6	7,012	362	51.6	1.00
Age of Mother* (years)							
10-19	59,340	840	14.2	59,340	1,005	16.9	1.19
20-29	143,489	1,470	10.2	143,489	1,707	11.9	1.17
30-39	31,250	324	10.4	31,250	363	11.6	1.12
≥40	1,736	25	14.4	1,736	28	16.1	1.12
Unknown[4]	4,586	180	39.2	4,586	189	41.2	1.05
Race*							
White	154,996	1,442	9.3	154,996	1,565	10.1	1.09
Black & Other**	85,405	1,234	14.4	85,405	1,564	18.3	1.27
Unknown[4]	—	163	—	—	163	—	—
Residence*							
Urban	133,452	1,570	11.8	133.452	1,734	13.0	1.10
Rural	102,566	1,106	10.8	102,566	1,395	13.6	1.26
Unknown[4]	—	163	—	—	163	—	—
Marital Status*							
In Wedlock	206,050	2,098	10.2	206,050	2,387	11.6	1.14
Out-of-Wedlock	34,351	578	16.8	34,351	742	21.6	1.29
Unknown[4]	—	163	—	—	163	—	—

[1]Does not include military personnel or non-resident births.
[2]Neonatal deaths per 1,000 live births.
[3]Ratio = Corrected NMR/Uncorrected NMR.
[4]The unknown category includes 163 reported neonatal deaths that were not linked to a birth certificate and linked records with missing information on the birth certificate.
*Calculations based on ≤1500 gram infants only, see text.
**Race designation other than Black comprise less than 1 per cent of births in this category.

the profile of the unregistered deaths between the two groups except for the birthweight, that the 453 unregistered deaths found for the 1974–1976 represented only 60 per cent of the unregistered deaths during that time period.

National Problem of Underregistration

To ascertain if other states had a similar problem, we obtained a copy of the computer tape of linked birth and infant-death certificates for the 1960 United States birth cohort from the National Center for Heath Statistics. We also obtained total live-birth data from the NCHS yearly report.[4] We then calculated state-specific weight-group-specific neonatal mortality rates for two weight groups: ≤ 1000 grams and 1001–1500 grams. The mortality rate for the 500–1000 gram weight group could not be calculated because of the unavailability of denominator data from reference.[4]

We then examined the 1960 study of infant mortality from linked records to identify those states with possible underregistration in 1960 (Table 4). Using a weight-specific neonatal mortality rate of 900 as a cutoff rate for the ≤ 1000-gram births, we determined that seven states (Alaska, Arkansas, Florida, Idaho, South Carolina, West Virginia, and Wisconsin) had rates that may reflect underregistration of neonatal deaths in 1960.‡ Rates for 1960 that are higher than 1,000 reflect underregistration of births or data processing errors. The number of states with possible underregistration increases when the same reasoning is applied for the 1001-gram to 1500-gram weight group. The cutoff rate, however, is more arbitrary and will determine the actual number of states that are suspect.

Discussion

This study identified two major procedural errors regarding the filing of neonatal death certificates at the county level in Georgia that contributed to underregistration of neonatal deaths during 1974–1977. It also identified minor procedural and coding errors within the vital records system at the state level that resulted in misclassification of live births by birth weight. The high underregistration occurred disproportionately in rural areas, for women under 30, unmarried

‡The weight-specific neonatal mortality rate for the U.S. in 1960 was 919 for ≤ 1000 grams. Caution should be exercised in comparing 1960 rates with those being achieved at present.

TABLE 3—Comparison of Selected Variables between 1977 and 1974–1976 Investigation of Unregistered Infant Deaths in Georgia

Variables	1974–1976 (N = 453) ≤1500 gms %	1977 (N = 198) All Infant's Weights %
Birth Weight		
<1500 grams	100	60
>1500 grams	—	40
Race*		
Black	72	72
White	28	28
Maternal Age**		
<20 years	40	29
≥20 years	60	71
Residence*		
Urban	34	40
Rural	66	60
Marital Status*		
In-Wedlock	65	70
Out-of-Wedlock	35	30
Infant Age at Death*		
Neonatal	100.0	99
Postneonatal	0.0	1

*Not statistically significant.
**Maternal age is not statistically significant when corrected for birthweight distribution.

TABLE 4—Weight-specific Neonatal Mortality Rates[1] for Two Weight Groups, by State, USA, 1960

State	<1000 grams	1001–1500 grams
Alabama	>1000[2]	531
Alaska	722	785
Arizona	938	601
Arkansas	743	473
California	964	583
Colorado	913	550
Connecticut	930	549
Delaware	>1000[2]	563
District of Columbia	947	431
Florida	835	518
Georgia	>1000[2]	527
Hawaii	964	589
Idaho	824	700
Illinois	958	516
Indiana	959	580
Iowa	>1000[2]	564
Kansas	911	590
Kentucky	930	601
Louisiana	935	485
Maine	>1000[2]	694
Maryland	>1000[2]	473
Massachusetts	>1000[2]	570
Michigan	945	528
Minnesota	919	611
Mississippi	983	542
Missouri	985	512
Montana	945	617
Nebraska	>1000[2]	627
Nevada	>1000[2]	537
New Hampshire	>1000[2]	634
New Jersey	946	544
New Mexico	904	500
New York	>1000[2]	467
North Carolina	925	557
North Dakota	>1000[2]	496
Ohio	981	547
Oklahoma	981	617
Oregon	>1000[2]	576
Pennsylvania	>1000[2]	542
Rhode Island	>1000[2]	454
South Carolina	806	519
South Dakota	>1000[2]	601
Tennessee	990	556
Texas	944	522
Utah	976	494
Vermont	>1000[2]	586
Virginia	985	570
Washington	975	576
W. Virginia	734	528
Wisconsin	886	511
Wyoming	>1000[2]	536

[1]Source: Numerator data from NCHS file on linked infant birth-death certificates in the United States in 1960. Denominator data from NCHS Report, Vol. I-Natality, 1960.
[2]Neonatal mortality rates of >1000 mean more deaths than births. This may have resulted from weights that were corrected after linkage was made.

mothers, and for black infants. Errors in the recording of birth weights for live-born infants occurred both at the hospital of birth and at the data entry level in the Vital Records Section in the State Heath Department.

We applied the same percentage breakdown of the 1977 investigation to the 1974–1976 investigation, and assumed that 453 unregistered deaths of infants weighing ≤ 1500 grams represented only 60 per cent of the total number of unregistered deaths. Therefore, an estimated 755 neonatal deaths occurred without being registered. For 1974–1977, nearly 1,000 (21 per cent) of all neonatal deaths were not registered.

Rogers, et al, reported incompleteness of death registration for low-birth-weight infants in North Carolina in 1959.[5] Since then, no follow-up of low-birth-weight infants has been carried out in North Carolina. The 1960 national study based on matched birth and infant-death certificates[1] did not determine by hospital chart review the outcome of births of infants weighing ≤ 1500 grams. In view of Rogers' finding and the apparent low-birth-weight-specific rates for seven states in 1960, it is likely that substantial underregistration existed at that time in those states.

The 1977 investigation in Georgia which matched in-hospital deaths with filed certificates was hindered by the lack of state regulations which would require filing a death certificate at any time after a death has been identified. Georgia law required that it be filed within 72 hours of death, but there is no regulation of filing a certificate if death had occurred more than a year earlier. Thus, not all the certificates were filed even after we identified specific instances of non-registration.

Our initial study was confined to Georgia infants whose birth weights were known; however, 7,012 of the 1974–1976 birth records did not have the birth weight recorded. We hypothesize that one reason a weight is not reported is that the infant had a low birth weight and/or was in distress. This hypothesis is supported by the high neonatal mortality rate for infants of unknown weight (Table 1). Since this unknown weight group may have been over represented by VLBW

infants, the 21 per cent underregistration of neonatal deaths probably underestimates unregistered neonatal deaths.

Georgia law allows burial of any person by any person, provided a death certificate is filed with the county registrar and a burial permit is obtained. Although we did not systematically identify reasons for not registering deaths, we did identify two patterns of failure to register. First, when hospital personnel rather than a mortician disposed of an infant's body, they often left the completed death certificate in the patient's chart and did not file it with the county registrar. Second, some morticians did not file certificates because they thought the infants had been born dead rather than alive. Most hospitals do not routinely distinguish stillbirths from early neonatal deaths on the release form to the mortician. Since Georgia law requires hospitals, not morticians, to file fetal death certificates, morticians do not file certificates on perinatal deaths that occur before birth. As a result, no certificate of death or stillbirth may ever have been registered when the mortician thought it was a fetal death. Contributing to this is the fact that disposal, rather than burial, may be more acceptable for low-birth-weight infants, a practice fostered by the high cost of burial.

Although the law has not been changed, the state's Vital Records Section instituted the following procedure in January 1978: hospitals are now required to submit a list of all fetal and infant deaths to the county registrar monthly for comparison with the death certificates filed during the month. For infants on the list that do not have associated death certificates, the county registrar will then notify the hospital or mortician, depending upon who disposed of the body, that a death certificate must be filed. Although this represents redundancy in registration, it is hoped that it will alleviate the problem. We plan a follow-up of the ≤ 1500-gram infants born in 1978 to assess the success of the changes initiated.

The effectiveness of programs designed to reduce neonatal mortality cannot be adequately evaluated without accurate vital statistics. The profile of the unregistered deaths in this study unexpectedly included differential underregistration for certain population groups, which might have led to erroneous conclusions about maternal and child health program effectiveness and needs. Future evaluation will depend on the registration system, and programs using registered neonatal mortality to evaluate program effectiveness must also evaluate the registration system.

REFERENCES

1. Center for Disease Control; Underreporting of Neonatal Deaths-Georgia, MMWR 1979; 28:253-254.
2. Department of Health, Education, and Welfare: A Study of Infant Mortality from Linked Records. NCHS Report, Series 20, No. 12, May 1972.
3. Institute of Medicine, Panel on Health Services Research: Infant Death: An Analysis of Maternal Risk and Health Care. Washington, DC, National Academy of Sciences, IOM, 1973.
4. Vital Statistics of the United States, 1960, Vol. 1, Natality, U.S. Department of Health, Education, and Welfare.
5. Rogers PB, Council CR, Abernathy JR: Testing death registration completeness in a group of premature infants. Public Health Rep 1961; 76:717-724.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance in reviewing this manuscript by Drusilla Burnham (NCHS) and Frances Porcher (CDC).

WFPHA Meeting to Convene in Calcutta

The Third International Congress of the World Federation of Public Health Associations (Geneva) will be held February 23-26, 1981 in Calcutta, in conjunction with the 25th annual conference of the Indian Public Health Association. The overall theme of the Congress will be "Primary Health Care—World Strategy." Additional sub-themes will include:

- Developing a National Plan of Action;
- Special Demonstration and Research Projects in Primary Health Care;
- Implementation of Field Programs: Supervision, Information, and Evaluation;
- Manpower Planning and Training; and
- Community Participation.

The Congress will provide a timely forum for the exchange of worldwide experiences of national primary health care programs, and the opportunity to identify approaches and methodologies applicable to all people of the world.

For details and further information, contact: Organizing Secretary, 3rd International Congress of WFPHA, and 25th Annual Conference of Indian Public Health Association, 110, Chittaranjan Avenue, Calcutta, 700073, India.