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Original Article

USING THE BIRTH RECORD TO DEVELOP A SCREENING INSTRUMENT FOR INFANT MORTALITY AND MORBIDITY

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Beginning April 1, 1992 all infants born in Florida are screened for increased risk of mortality and morbidity. To develop the screening criteria, birth records for 1989 were linked to infant death records. This data was used to select factors from the birth record that are good predictors of postneonatal death. It was found that a score based on 10 items from the birth record includes 14 percent of the births and 48 percent of the post-neonatal deaths. Infants that screen positive are 6.2 times more likely to die postneonatally than those that screen negative. This screening criteria is applied to all infants born in Florida since 4/1/92 and those that screen positive are offered enhanced case management services.

Background Information

In 1991 the Florida Legislature passed legislation generally referred to as the Healthy Start Initiative (Florida Statutes section 383.14, 1990 supplement). The law specified that an infant screening instrument was to be selected by the Florida Department of Health and Rehabilitative Services and applied to all infants born in Florida to identify those with greater than average risk of having health problems.

The screening criteria selected was developed by the Florida Department of Health and Rehabilitative Services, State Health Office and approved by the Healthy Start Advisory Committee. The committee included representatives of Florida County Public Health Units, two Florida universities, the state legislature and seven representatives from private sector health care.

The purpose of this paper is to describe the development of the screening instrument and present preliminary data regarding its effectiveness.

Summary of Methods

To determine which items on the birth certificate are useful predictors of health risk, an outcome measure is needed. For this analysis the outcome measure is infant death at age 28 to 364 days (also known as post-neonatal death). The assumption is that a group of infants that have a high proportion of post-neonatal deaths will include survivors of, that by definition have the same characteristics as the fatalities. Even though the survivors did not die, it is assumed that since they have the same risk factors as the fatalities, they are at increased risk of morbidity and likely to require more intensive health care than infants without these characteristics.

The data file used for this analysis includes all births to Florida residents in 1989. In cases where the infant died before one year of age, the birth records are linked to the corresponding death records. There were 192,887 births in this file. Of these, 1,250 died in the neonatal period (0 to 27 days) and 521 died post-neonatally (28 to 364 days).

This file was used to calculate the death rates for all of the relevant factors on the birth certificate. For example, there are 1,050 births recorded as having Abnormal Condition number 7 on the birth certificate. This is labeled "Assisted ventilation > or = 30 min." on the birth certificate. Out of the 1,050 births with this condition, 34 died before they were one day of age; 85 died at age one to 27 days; and 24 died at age 28 to 364 days. The post-neonatal death rate for infants age 28 to 364 days with this condition is calculated from the above to be 25.78 deaths per 1,000 births. As a comparison, the same rate for all of the births is 2.72. This means that infants recorded as having assisted ventilation > or = 30 minutes were approximately nine times more likely to die at age 28 to 364 days. However, most of the infants (907 out of 931) with this condition did not die. Based on the assumption explained above, these survivors are expected to require more intensive health care than the average child.

This analysis was done for all of the potentially relevant factors on the birth certificate. Many of the factors were too rare for inferences to be made about their associated risk, and some factors were not associated with high risk for post-neonatal death. In general, factors were considered for use in the screening criteria if they occurred in more than 1,000 births and had an associated risk of at least twice the average risk. The selected factors are listed in Table I with their post-neonatal death rates.

It can be seen that the factors in Table I all meet the two

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Table I. Florida infant death rates at age 28 to 364 days (PNND) by risk factor for 1989 births (Post Neonatal Death Rates)

INFANT RISK FACTOR	PNND RATE PER 1,000 BIRTHS WITH RISK FACTOR	PNND RATE PER 1,000 BIRTHS WITHOUT RISK FACTOR	RISK RATIO	NUMBER WITH RISK FACTOR	PERCENT WITH RISK FACTOR	HEALTHY START SCORING POINTS
1 Birth Weight < 2000 g	25.7	2.1	12.2	4,861	2.5	4
2 Abnormal Conditions of Newborn	22.5	2.6	8.7	1,380	0.7	4
3 Congenital Anomalies of Newborn	17.1	2.4	7.1	3,864	2.0	4
4 Prenatal Care	7.0	2.5	2.8	8,518	4.4	1
5 Mother's Marital Status	4.4	2.0	2.2	58,642	30.6	1
6 Mother's Smoking	5.1	2.6	2.0	26,936	14.1	1
7 Mother's Age	5.2	2.6	2.0	10,706	5.6	1
8 Mother's Race Non White	4.3	2.2	2.0	47,367	24.7	1
9 Mother's Drinking	5.1	2.6	2.0	8,247	4.3	1
10 Mother's Education	3.8	2.5	1.5	33,991	17.7	2

FACTOR DEFINITION

1	Infants with a birth weight less than 2000 grams.
2	Infants with fetal alcohol syndrome, Hyaline membrane disease/RDS, and/or Assisted ventilation > or = 30 minutes, under item 44 on the Birth Certificate.
3	Infants with 1 or more congenital anomalies under item 45 on the Birth Certificate.
4	Infants born to mothers who had no or unknown prenatal care on the Birth Certificate.
5	Infants born to mothers whose marital status was not married or unknown on Birth Certificate.
6	Infants born to mothers who smoked 10 or more cigarettes per day, or smoked an unknown number per day according to the Birth Certificate.
7	Infants born to mothers age 10 to 17 according to the Birth Certificate.
8	Infants born to mothers who were non white.
9	Infants born to mothers who used alcohol during the pregnancy, according to the Birth Certificate.
10	Infants born to mothers with less than a 12th grade education at age 19 or above, or who had an unknown amount of education at age 19 or above.

conditions for inclusion in the risk criteria, except the mother's education factor. For example, the post-neonatal death rate for infants with "abnormal conditions of newborn" is 22.5 per 1,000 infants versus 2.6 for infants who do not have this factor. The risk ratio is 22.5/2.6 or 8.7. This meets the first condition which is a risk ratio of two or more. In the fourth column of Table I the number of births positive for the abnormal conditions factor is 1,380. This meets the second condition of 1,000 or more births positive for the factor.

The mother's education factor does not meet the risk ratio condition since the risk ratio is 1.5, but based on the professional judgment of several educators, this factor is included in the risk criteria and given a slightly greater weight (see explanation of the risk scoring algorithm below) than other factors with comparable risk ratios. The basis for this is the assertion that the mother's education is more closely associated with infant morbidity than post neonatal death so post neonatal death is a biased proxy for morbidity in the case of mother's education. The emphasis given to mother's education is based on an assumed association with infant morbidity in addition to the association with post neonatal death. Thus the predictors of death are not necessarily good predictors of other important non medical outcomes.

The screening criteria was then developed by using the factors to classify the infants into several groups based on level of risk. This is illustrated by Table II. Infants with the factor associated with the highest risk are counted as members of group 1 in Table II. Births with the factor associated with the second highest risk are counted as members of group 2 if they are not already included in group 1. This is done for all of the selected risk factors until the last group has none of the selected risk factors. In cases where births qualify for membership in two or more groups, they are counted only in the highest risk group for which they qualify. Risk rates are then calculated for each group.

The classification scheme used in Table II is an attempt to assess the contribution that each individual risk factor makes to the risk criteria. For example, in Table II the infants in group 1 have one risk factor, birth weight under 2,000 grams. These infants have a very high post-neonatal death rate of 25.7 per 1000 infants. These infants are therefore classified as high risk.

The question then becomes which of the remaining infants should also be classified as high risk. Table II provides information directed at this question in the data presented for group 2. This group includes infants that have one or more abnormal conditions (see Table II), and are not included in group 1. None of the infants in group 2 have a birth weight below 2,000 grams. Infants in group 2 have a post-neonatal death rate of 14.2 per 1000 infants. This is a high death rate compared to the overall rate of 2.7, so these infants are also included in the high risk group.

The next question of the infants not included in group 1 or 2 should be classified as high risk. This question is addressed by the data for group 3 in Table II. Group 3

Table II. Infant death rates at age 28 to 364 days by risk group for 1989 (Post Neonatal Death Rates)

GROUP	1 POST NEONATAL DEATHS	2 BIRTHS	3 RATE PER 1,000 BIRTHS	4 CUMULATIVE PERCENT DEATHS	5 CUMULATIVE PERCENT BIRTHS
1 Birth Weight < 2000 g	125	4,861	25.7	24.0	2.5
2 Abnormal Conditions	12	848	14.2	26.3	3.0
3 Congenital Anomalies	38	3,429	11.1	33.6	4.8
4 Score = 7+	18	3,139	5.7	37.0	6.4
5 Score = 6	10	2,290	4.4	39.0	7.6
6 Score = 5	11	2,396	4.6	41.1	8.9
7 Score = 4	37	9,505	3.9	48.2	13.8
8 Score = 3	53	17,012	3.1	58.3	22.7
9 Score = 2	75	31,062	2.4	72.7	38.9
10 Score = 1	56	35,693	1.6	83.5	57.5
11 Score = 0	86	81,427	1.1	100.0	100.0
TOTAL	521	191,662	2.7		

GROUP	DEFINITIONS
1	Births with a birth weight less than 2,000 grams.
2	Births that are not in group 1, that have 1 or more of the following factors: Hyaline membrane disease/RDS, Assisted ventilation > = 30 minutes, Fetal alcohol syndrome (Item 44 on Birth Certificate).
3	Births not in group 1 or 2, that have 1 or more congenital anomalies (Item 45 on the Birth Certificate).
4	Births that are not in groups 1 to 3, that have a score of 7 or more.
5	Births that are not in groups 1 to 4, that have a score of 6.
6	Births that are not in groups 1 to 5, that have a score of 5.
7	Births that are not in groups 1 to 6, that have a score of 4.
8	Births that are not in groups 1 to 7, that have a score of 3.
9	Births that are not in groups 1 to 8, that have a score of 2.
10	Births that are not in groups 1 to 9, that have a score of 1.
11	Births that are not in groups 1 to 10, that have a score of 0.

includes infants, who are not included in groups 1 or 2, who have one or more congenital anomalies. The post-neonatal death rate for these infants is 11.1 per 1,000 infants. Compared to the overall rate of 2.7, this is relatively high, so the births in group 3 are also classified as high risk.

This process is repeated with groups 4 through 11. The infants in groups 1 through 7 are all classified as high risk based on their relatively high rates of post-neonatal death. The infants in groups 8 through 11 do not meet the criteria that qualify them for inclusion in any of the groups 1 through 7, and they have relatively low post-neonatal death rates. These infants are therefore not classified as high risk.

Discussion

It should be noted that there are various multivariate statistical methods that could be used instead of the hierarchical grouping method described above. However, the above method was used because of its comparative ease of application and the practical focus of the results. Also this method is understandable to a wider audience than multivariate methods. This last advantage can be important when the screening criteria developed is to be used by a large number of practitioners with various levels of training in statistical methods.

The decision regarding the level of risk used to classify infants as high risk is as much a policy decision as it is a scientific one. In Florida the decision is that infants in groups 1 through 7 all have risk levels high enough to classify them as high risk. According to column 5 in Table II, this includes 13.8% of all infants born in Florida in 1989 and from column 4 in Table II it can be seen that 48.2% of the post-neonatal deaths occurred among this 13.8% of the infants. Incidentally, the 48.2% also represents the sensitivity of this screen when infants in groups 1 through 7 are classified as positive. The significance of being classified high risk is that intensive services (care coordination, home visits, nutrition and parenting education) will be provided for infants in this group. Including group 8 in the high risk group increases the percentage of high risk infants from 13.8% to 22.7% and increases the sensitivity from 48.2% to 58.3%. This is a small gain in sensitivity in exchange for a large increase in workload. Since the infants in group 8 have a relatively low post-neonatal mortality rate of 3.1 per 1,000 births, they are not included in the high risk group. With additional funding and service delivery capacity, it might be decided that infants in group 8 should be added to the high risk category. The point here is that it is a program and policy decision and not a purely quantitative problem.

Classifying infants into the group in Table II is too complicated to be done on a routine basis. To make the risk criteria easier to use operationally, the scoring values shown

in the last column of Table I are applied. For example, an infant who has congenital anomalies and whose mother smoked, would be assigned 4 points for the congenital anomalies factor and 1 point for the smoking risk factor, for a total risk score of 5. The scoring values are constructed so that infants in groups 1 through 7 in Table II are given a score of 4 or greater and classified as high risk.

Since April 1, 1992 all infants born in Florida have been scored using this algorithm. Table III shows the post-neonatal death rates associated with each score and Graph 1 is a graph of death rates by risk score. Table III and Graph 1 show a steady and substantial increase in risk of post-neonatal death as the score increases. Infants that screen positive (score of 4 or more) are 6.1 times more likely to die post-neonatally than those that screen negative.

In an effort to reduce their health risks, Healthy Start infants are given enhanced services from county public health units and private health care providers. The enhanced services are, at present, mainly case management, home visits, parenting education and nutritional counseling. The hope is that more educational, psychosocial and economic services will be available in the future.

Conclusion

It appears that the data on the birth certificate can be used effectively to identify infants with higher than normal risk of death at age 28 to 364 days. If the assumption is accepted that death is strongly associated with morbidity, then the birth record data can also be used as a screening tool for infant morbidity.

The screening tool will be evaluated for performance and utility as soon as enough data is available to do so and also periodically thereafter. This will ensure that the instrument continues to be effective and will also facilitate continuous improvement of the form based on new data.

Table III. Florida 1989 Births

FLORIDA 1989 BIRTHS
CLASSIFIED BY HEALTHY START INFANT RISK SCORE

HEALTHY START RISK SCORE	1989 BIRTHS	MATCHED INFANT DEATHS	INFANT DEATHS PER 1000 BIRTHS	MATCHED POST NEONATAL DEATHS	POST NEONATAL DEATHS PER 1000 BIRTHS *
0	81,661	138	1.7	86	1.1
1	35,927	95	2.6	56	1.6
2	31,427	112	3.6	75	2.4
3	17,268	71	4.1	53	3.1
4	12,488	272	21.8	66	5.4
5	3,985	171	42.9	34	8.8
6	3,564	192	53.9	35	10.3
7	2,397	109	45.5	26	11.2
8	1,932	192	99.4	37	20.8
9+	2,238	419	187.2	53	28.3
	192,887	1,771	9.2	521	2.7

* Infants that died before 28 days are excluded

Graph 1. Florida post neonatal death rate per 1,000 births by Healthy Start risk score based on 1989 birth data.