Neonatal Tetanus Mortality in Veracruz, Mexico, 1989[1]

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This article describes a survey conducted in the State of Veracruz, Mexico, to estimate neonatal tetanus (NNT) mortality. The survey, which entailed visits to 72 720 households, collected data on 8 401 live births and 209 infant deaths occurring between April 1988 and May 1989. Twenty-six of the 209 fatalities conformed to a WHO standard case definition of death from neonatal tetanus. The estimated neonatal tetanus mortality was thus 3.1 deaths per 1 000 live births (95% confidence limits = 1.7, 4.5). Comparison of this rate to reported figures suggests that for every NNT death recorded in Veracruz during the study period, as many as 50 others went unreported.

A case-control study nested within the survey was conducted to assess preventable NNT risk factors. Limited information on 13 NNT deaths and 217 controls showed an increased risk for neonates who were delivered at home and whose parents' ethnic background was Mexican Indian. Five of the 13 fatalities had their umbilical cords cut with a domestic or traditional cutting tool such as a reed cane, as compared to none of the 217 controls. The observed vaccine efficacy of 2+ doses of tetanus toxoid was 70% (95% confidence limits = 52, 100). Both the mothers of neonates who died of NNT and their controls missed an average of five opportunities to receive tetanus toxoid. These findings underscore the need to launch a perinatal health program serving Mexico's high-risk populations.

Neonatal tetanus (NNT), a target disease of the World Health Organization's Expanded Program on Immunization (EPI), is perhaps the most refractory of those diseases to current strategies. This is partly because in many places im-

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munizers must target two groups: young girls (to protect their future offspring) and women of reproductive age (the main target group in countries without long-standing immunization programs).

Following NNT declines in the developed world and paralleling reported declines in most developing countries (1), since the 1930s Mexico has seen a sharp decline in recorded NNT deaths. The figures have gone from 8 200 recorded infant deaths from NNT (10 per 1 000 live births) in 1930 to 4 053 (2 per 1 000) in 1957 (2) to an average of about 300 annually (0.2 per 1 000) in the early 1980s (3). However, the accuracy of these recorded data is open to question, partly because Mexico's national disease surveillance system has reported fewer NNT cases than the number of NNT deaths recorded on death certificates (3).

In 1988 and 1989 the respective NNT incidences reported for Mexico were 0.053 and 0.043 cases per 1 000 live births (4). According to 1988 National Health Survey figures (5), the percentage of newborns delivered at hospitals ranged from 90% in Northern Mexico to just under 50% in Central and Southern Mexico. A 1990 national survey estimated coverage with at least two doses of tetanus toxoid to be 32.3% among women of reproductive age (5).

Underestimation of this public health problem by routine surveillance can lead to allocation of fewer resources for immunization. Within this context, special NNT mortality surveys carried out in various parts of the world have provided valuable information for decision-making (6, 7). Only a few such studies have been reported in Latin America, but they have consistently provided higher incidence estimates (8–10) than those obtained from routine surveillance. One of the most recent (10), carried out in hyperendemic areas of the Mexican State of Jalisco, documented a pronounced underrecording of NNT deaths.

The 1989 study reported here was carried out in Mexico's large (71 699 km^2) and populous (6 832 271 inhabitants) State of Veracruz. Two previously published reports (11, 12) had documented a very high incidence of NNT there, especially in rural areas. Registered tetanus mortality among Veracruz infants in 1956–1960 was 1.5 deaths per 1 000 live births; and while only seven cases were reported to the Veracruz Health Secretariat in 1987, some 35 deaths caused by NNT were officially registered that year. These deaths made the state's reported NNT mortality (approximately 0.15 deaths per 1 000 live births) one of the highest in the country.

Our study had the following principal aims: (1) to estimate the number of NNT deaths in Veracruz between 3 April 1988 and 15 May 1989, together with the magnitude of suspected underreporting; and (2) to assess preventable risk factors for NNT.

METHODS

Probability Sample Survey

The inference population for the sample survey was all of the babies born in the State of Veracruz between April 1988 and May 1989. These babies were identified by selecting and visiting a probability sample of housing units. In turn, the housing units were selected by means of a three-stage cluster process.

Using systematic random sampling, we selected municipalities or groups of them, then localities, and finally individual dwellings (or blocks in the case of large urban areas). In all, 942 Veracruz localities were selected, these reflecting the state's distribution of urban and rural strata, districts (administrative units served by a single regional office that report to the state government), and major ethnic groups.

The sampling scheme employed an equal probability sampling design and

simplified estimation procedures (13). Using this approach, assuming a frequency of 2.5 NNT deaths per 1 000 live births ($P = 0.0025$ at the 95% confidence level) with a precision of 0.001285 and an anticipated design effect of 1.7, it was estimated that the households sampled should experience 9 860 live births during the study period (14).

Death risk data were collected by asking mothers or guardians in the selected households "Since last Easter (April, 1988) has a baby been born to a woman living in this house?" and "Since last Easter (April, 1988) has a baby died who was born to a woman who lives here?" Easter being a fundamental event in Mexican culture, that date was selected as a cutoff to reduce recall error. It was also felt that reducing the study period to approximately one year, as recommended in WHO guidelines, would help improve the recalled history of reproductive events (14).

If a live birth was reported, the informant was asked about the birth attendant (i.e., whether he or she was a physician, nurse, traditional attendant, relative, or simply the mother herself). If an infant death was reported, a verbal "autopsy" (14, 15) was conducted in an effort to identify the most likely cause of death and to separate live births from stillbirths and abortions. This method has shown high (100%) sensitivity in screening for NNT deaths (15). In addition, informants were asked to select the cause of death from a published list of local names (11, 12), a list enlarged on the basis of a pilot survey that identified relevant folk names (e.g., "mal del arco", "trabazón de la quijada", "muezo"). This section of the interview dealing with NNT deaths had been pilot tested in the field through interviews with mothers or adult relatives of known NNT cases.

The local survey supervisors received detailed instructions on how to follow the sampling scheme (i.e., how and when to use a table of random numbers, divide the city into sectors, choose one sector at random, etc.). Interviewers (most of them public health nurses or community health workers) received a day of training and then field practice to familiarize them with the questionnaire and interview process.

Following the sample design, the supervisor indicated the households to be visited. The interviewers were instructed to fill out a questionnaire for each visited household. One or more full-time staff members in each local health district supervised data collection in the field. Members of the survey group also helped by coding questionnaires and reviewing the procedures followed in the field. The data collected were then entered into a database management system.

These data were later analyzed using the point and variance estimators available in PC-SUDAAN (16). The analysis weight assigned to each live birth was the ratio of the estimated number of dwellings from the sampling frame divided by the number of dwellings in the sample; and this was used to estimate totals, under the assumption that an equal probability sample of households was obtained.

The indicated variables were defined as follows: *Rural/urban:* Localities were classed as rural if they had less than 5 000 inhabitants, all others being considered urban. *Live birth:* A birth where it was reported that the baby cried or moved voluntarily after delivery. *Neonatal death:* A death occurring within the first 30 days after birth. *Death due to NNT:* A death meeting all three of the following criteria: (1) occurrence in an infant between 3 days and 1 month old who (2) had no feeding problems but was unable to suckle and (3) had any of the following: lockjaw, sardonic expression, opisthotonos, spasms, or paroxysms (convulsions).

The parameters of interest were the ratios of infant, neonatal, and NNT deaths

to the number of live births. Live births used to derive denominators included all those infants from 1 to 11 months 29 days of age at the date of the interview, as these had already gone through the "at-risk" period. A Z-test (placing the ratio of the mean difference over the standard error) *(13)* was used to test hypotheses of differences between proportions (i.e., ratios) by demographic domain (rural vs. urban) and birth attendant (physician vs. nonphysician). The *P* values obtained are two-tailed and take the sample design into account.

Case-control Study

An unmatched case-control study was carried out. This used NNT deaths detected during the survey as cases and a random sample of live-born survey infants without NNT as controls. The aim was to examine certain factors: health care status (as indicated by Social Security status), tetanus toxoid immunization of the mother, and missed maternal opportunities for obtaining tetanus toxoid immunization. Therefore, the number of times the mother had attended a health care unit during her pregnancy was ascertained, and the number of missed opportunities of tetanus toxoid immunization was determined. Also, the informants (mothers or caretakers) reporting on subjects who died were given a second, more detailed interview to ascertain major causes of death. This interview took place during a second visit by a member of an interview team that had received *ad hoc* training for this purpose. During this interview, the informants were shown three clinical slides of NNT patients with trismus and spasmus.

Caretakers of both cases and controls were interviewed regarding prenatal care. More specifically, interviewers asked about whether the mother was given tetanus toxoid, the place and hygienic con-

ditions of the delivery, the identity of the delivery attendant, and a number of other questions directed at assessing demographic and socioeconomic variables including maternal age, formal maternal education, family income, and housing and sanitary conditions.

Regarding analysis with respect to these variables, comparisons between cases and controls were made using the null hypothesis that the exposure odds ratio (OR) was not statistically different from 1. Ninety-five percent confidence intervals were calculated using Fisher's exact method as described by Martin and Austin *(17)*.

Following calculation of the OR, stratified analysis was performed to control for confounding variables and detect interaction *(18)*. After that, statistical modeling by means of a logistic regression model was carried out. A variable entered into the model was selected if it was found to represent a different dimension in the analytic framework developed by Mosley and Chen *(19)* and to meet the definition of confounder in the absence of intervening variables *(18)*. The statistical goodness of fit of the final model was tested through empirical comparison of predicted and observed probabilities and the goodness of fit statistic of Hosmer and Lemeshow *(20)*. Vaccine efficacy was estimated using the Greenwood and Yule estimator, as modified by Haber et al. *(21)*.

RESULTS

Sample Survey

Of the initial 942 localities, only 840 (89.2%) were found qualified for inclusion in the sampling frame. The remaining 10.8% were either duplicated in the lists or unknown to the health district staff. Within the 840 study localities, 316 interviewers visited 72 720 dwellings be-

tween 4 and 31 May of 1989. Detailed information about the results of these household visits was recorded in 71 978 cases, there being 742 instances in which the results of the household visit were not recorded by the interviewer. At 25 007 of the 71 978 dwellings (34.7%) the respondent was the mother of at least one child; at 37 402 (52.0%) the respondent was a housewife without children or some other person; at 404 (0.6%) the informant refused to participate in the interview; and at 9 165 (12.7%) nobody was home. The overall response rate was 87%.

With respect to the size of individual localities, the interviewers visited 37 108 dwellings (51.1% of those with known locations) in 52 localities defined as urban (with at least 5 000 inhabitants each). They also visited 3 713 dwellings (5.1% of the total) in localities with 2 500 to 4 999 inhabitants and 31 843 dwellings (43.8% of the total) in localities with less than 2 500 inhabitants. In 56 of the 72 720 households visited, the questionnaire did not identify the locality involved. Twenty-six percent of the household visits were carried out in the seven major urban areas of Veracruz: Coatzacoalcos, Xalapa, Córdoba, Orizaba-Río Blanco, Poza Rica-Coatzintla, and Minatitlán. According to estimates based on the sampling frame, we expected to visit 73 514 dwellings; the sample survey finally included 99% of this number (i.e., 72 720 dwellings). Except for the primary sampling unit (PSU) of Tantoyuca, all the PSUs included more than 85% of the localities targeted. A political dispute in Tantoyuca at the time of the survey prevented the survey from being conducted there. In general, it was found that localities randomly selected but not included in the survey lacked proper identification in the sampling frame.

Regarding live birth and mortality estimates, we found that of the 9 879 babies enumerated in the sample, 8 401 were born within the study period of Easter (April) 1988 through May 1989 and were 1–12 months old. (On the basis of this finding, the crude birth rate was estimated at 2.7%.) There were also 209 infant deaths, indicating an infant death risk of 25 deaths per 1 000 live births, the 95% confidence interval (CI) being 18.8, 31.0. Using these data, the total number of infant deaths estimated for the State of Veracruz was 4 521. Among these fatalities were 55 neonatal deaths, indicating a neonatal death risk of 6.6 deaths per 1 000 live births (95% CI = 4.2, 8.8) and an estimated total of 1 190 neonatal deaths in the State of Veracruz. A peak of infant deaths was recorded in July and August of 1988, despite a statistically significant tendency for the number of reported deaths to decline as the time between the death and the interview increased (X^2 for goodness of fit with 11 degrees of freedom = 36.5, P = 0.000142; and X^2 for trend with 1 degree of freedom = 4.7, P = 0.03). As Figure 1 suggests, this trend was influenced by the large number of deaths (37, accounting for 18% of the total) that reportedly occurred in the month preceding the interview.

Table 1 displays basic data from the sample survey by health district. It is

Figure 1. Infant deaths reported to the NNT survey interviewers, by length of recall period.
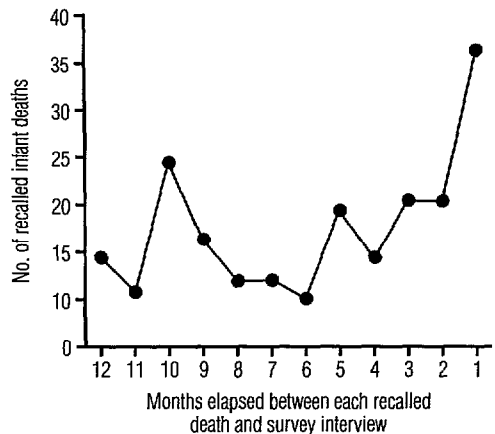
Table 1. A summary of sample household, birth, and mortality data from the 1988–1989 Veracruz neonatal tetanus mortality survey, showing the total numbers of live births and infant, neonatal, and NNT deaths found in the study sample and estimated for each health district and the State of Veracruz.

Health district	No. of households in sample	Live births		Infant deaths			Neonatal deaths			NNT deaths		
		No. in sample	Est. total no.	No. in sample	Est. total no.	Rate*	No. in sample	Est. total no.	Rate*	No. in sample	Est. total no.	Rate*
Pánuco	3 801	455	9 843.5	12	259.6	26	7	151.4	†	6	129.8	†
Tuxpan	7 464	1 085	23 472.9	25	540.8	23	5	108.2	†	1	21.6	†
Poza Rica	7 712	1 043	22 564.3	6	129.8	6	1	21.6	†	0	0.0	†
Martínez de la Torre	4 672	574	12 417.9	13	281.2	23	7	151.4	†	5	108.3	†
Xalapa	6 769	705	15 252.0	25	540.8	35	9	194.7	†	1	21.6	†
Córdoba	9 893	1 169	25 290.2	46	995.2	39	6	129.8	†	2	43.3	†
Orizaba	5 645	494	10 687.2	26	562.5	53	6	129.8	†	1	21.6	†
Veracruz	7 405	511	11 055.0	6	129.8	12	2	43.3	†	1	21.6	†
Cosamaloapan	3 883	456	9 865.0	6	129.8	13	1	21.6	†	1	21.6	†
San Andrés Tuxtla	7 971	1 101	23 819.0	24	519.2	22	9	194.7	†	6	129.8	†
Coatzacoalcos	7 459	792	17 134.1	20	432.7	25	2	43.3	†	2	43.3	†
Total	72 674‡	8 385§	181 401.1	209	4 521.5	25	55	1 189.8	7	26	562.5	3.1

*Rate per 1 000 live births.
†Numbers insufficient to provide a precise estimate.
‡In 46 instances there was insufficient information to determine the district where the visit was made.
§Sixteen observations with missing data.

noteworthy that all the districts except Poza Rica were found to have had NNT deaths. Due to sample size limitations, however, it was not possible to meaningfully compare differences in neonatal or NNT deaths by health district.

As may be seen, 26 neonatal fatalities in the sample met the previously cited definition of NNT death, yielding a rate of 3.1 NNT deaths per 1 000 live births (95% CI = 1.7, 4.5). Applying this rate statewide would indicate that some 563 NNT deaths per year were occurring in Veracruz, a total considerably exceeding the 11 NNT deaths reported in the vital statistics records for 1989.

Regarding sample survey risk factors, urban-rural variations are shown in Table 2. The difference between estimated infant mortality in the rural versus urban strata was not statistically significant at the 0.05 probability level. There was a significant difference between estimated neonatal mortality in the rural and urban strata but not between estimated NNT mortality in these strata.

Most (60%) of the live births in the sample were attended by physicians or nurses, 37% by traditional birth attendants, and 3% by others (relatives or no one except the mother). Comparisons of infant, neonatal, and NNT mortality by type of birth attendant were made using a Z-test (Table 3). The data showed that newborns whose deliveries were not attended by a physician or nurse had higher

Table 2. Urban and rural mortality estimates obtained from the 1988–1989 Veracruz neonatal tetanus mortality survey.

	Infant deaths			Neonatal deaths			NNT deaths		
	No. in sample	Est. total no.*	Rate†	No. in sample	Est. total no.*	Rate†	No. in sample	Est. total no.*	Rate†
Urban localities (≥5 000 inhabitants)	67	1 449.5	21‡	12	259.6	4§	7	151.4	2‖
Rural localities (<5 000 inhabitants)	142	3 072.0	27‡	43	930.3	8§	19	411.0	4‖
Total	209	4 521.5	25	55	1 189.9	7	26	562.5	3

*Projected deaths for the entire stratum in Veracruz or the entire state.
†Deaths per 1 000 live births.
‡$P = 0.14$.
§$P = 0.015$.
‖$P = 0.28$.

Table 3. Mortality estimates by type of birth attendant obtained from the 1988–1989 Veracruz neonatal tetanus mortality survey.

Type of birth attendant	Infant deaths			Neonatal deaths			NNT deaths		
	No. in sample	Est. total no.*	Rate†	No. in sample	Est. total no.*	Rate†	No. in sample	Est. total no.*	Rate†
Physician/nurse	87	1 882.2	17‡	23	497.6	5§	9	194.7	2§
Traditional attendant/ other	86	1 860.5	26‡	19	592.3	10§	17	367.8	5§
Total	173‖	3 742.7	21	42¶	1 089.9	7	26	562.5	3

*Projected deaths for the entire stratum in Veracruz or the entire state.
†Deaths per 1 000 live births.
‡$P = 0.08$.
§$P = 0.02$.
‖Thirty-six infant deaths with missing values.
¶Thirteen neonatal deaths with missing values.

infant, neonatal, and NNT mortalities than those whose deliveries were so attended. Differences in neonatal and NNT mortality were found to be statistically significant.

The percentages of the 8 401 infants alive at interview who were reported to have had a severe episode of diarrhea or acute lower respiratory infection within the preceding 15 days were 7.1% and 5.3%, respectively. No significant differences were observed in the incidence of these disease episodes among infants born to urban, semi-urban, or rural dwellers.

Causes of Death: The Verbal Autopsy

Seventy-seven verbal autopsies were performed to study causes of neonatal mortality. In all, during this second visit we were able to reinterview 13 of the 26 caretakers whose infants died of NNT and 19 caretakers whose infants perished during the neonatal period of other causes. Variables investigated to reach a diagnosis of NNT are shown in Table 4. We also compared signs identified by caretakers with classical clinical features depicted in slides. Among the 13 reinterviewed caretakers of infants who died of NNT (see below), 10 recognized that their newborns had trismus, spasms, or opisthotonos. Of the 7 caretakers who reported spasms and opisthotonos associated with these NNT deaths, 6 (85.7%) correctly identified both conditions when these were shown to them on slides.

Case-control Study

The reasons why we were able to reinterview only 13 of the 26 caretakers whose initial responses indicated their infants had died of NNT included lack of the personnel or transportation needed to return to hard-to-reach communities (in 6 cases), inability to relocate the household (in 4 cases), and failure to find anyone at home on the second visit (in 3 cases).

A comparison of selected factors relating to the 13 reinterview cases and the 217 control subjects is shown in Table 5. Regarding treatment of the umbilical cord and stump, we sought differences in specific practices at the time of delivery and during the first few days of life. Among other things, we asked whether cowdung, ash, medicinal plasters, or other materials were applied, but failed to detect any particular pattern. However, virtually all the controls had the umbilical cord cut with a scissors or bistoury, whereas 42% of the NNT victims had theirs cut with something else (i.e., a razor blade in one case, a sharp-edged reed in two others). Other significant differences involved a number of socioeconomic variables, health care access, and the type of health care the mother and newborn received. More specifically, the

Table 4. Comparison of clinical features of NNT neonatal deaths with those of non-NNT neonatal deaths in the Veracruz survey.

| Clinical feature | NNT deaths | | Non-NNT deaths | | Two-tailed P value* |
	No. (n = 13)	%	No. (n = 19)	%	
Lockjaw (trismus)	10	76.9	4	9.5	0.003
Sardonic expression	7	53.8	4	9.5	0.06
Opisthotonos	7	53.8	2	4.8	0.01
Paroxysms (convulsions)	5	38.5	1	2.4	0.03
Spasms	7	53.8	2	4.8	0.01

*Fisher's exact test.

Table 5. Comparison of 13 Veracruz survey subjects who died of NNT and 217 control subjects in terms of their exposure to selected factors. Because of missing observations, the base changes for some characteristics.

Factor	Neonates dying of NNT (n = 13) Exposed No.	(%)	Unexposed No.	(%)	Control subjects (n = 217) Exposed No.	(%)	Unexposed No.	(%)	Odds Ratio	(95% CI)*
Home delivery	10	(77)	3	(23)	56	(26)	161	(74)	9.6	(2.3, 55.5)
Mexican Indian (e.g., Náhuatl, Otomí)	5	(38)	8	(62)	15	(11)	201	(89)	8.4	(1.9, 33.0)
Uninsured (i.e., no Social Security)	12	(100)	0	(0)	150	(70)	60	(30)	∞	(1.2, ∞)
Traditional birth attendant	7	(88)			91	(42)			9.5	(1.2, 436.7)†
Attended by physician/ nurse	1	(12)			125	(58)			1.0†	
Umbilical cord cut with scissors or bistoury	7	(58)	5	(42)	213	(100)	0	(0)	0	(0, 0.046)
Not completely vaccinated (<2 TT)	10	(77)	3	(23)	109	(50)	108	(50)	3.3	(0.8, 191)
No prenatal visit	11	(92)	1	(8)	192	(89)	24	(11)	1.4	(0.2, 61.6)
Dwelling with dirt floor	11	(85)	2	(15)	88	(41)	129	(59)	8.0	(1.7, 76.0)
Limited maternal education (<6 years)	12	(92)	1	(8)	125	(58)	92	(42)	8.8	(1.3, 381.6)
No refrigerator in dwelling	12	(92)	1	(8)	151	(70)	66	(30)	5.2	(0.7, 227.6)
Mean missed opportunities for TT vaccination in prenatal care visits	4.8				5.0					(n.s.)‡
Mean maternal age (years)	28.9				24.8					($P = 0.03$)§

*Fisher's exact CI.
†The referent group for both cases and controls consisted of those babies whose delivery was attended by a physician or nurse.
‡n.s. = not significant (Student's t-test).
§Student's t-test.

NNT victims' mothers were more likely to be Mexican Indians, to have delivered their babies at home, and to live in homes without refrigerators and with dirt floors. They were also less likely to have health insurance, to have completed primary school, and to have had their deliveries attended by a nurse or physician.

Logistic regression analysis affirmed that access to and use of the health care system made a difference in the risk of NNT death. Lack of Social Security coverage was a significant factor, but because all the NNT deaths occurred among the uninsured, a precise estimation of its impact by this method was precluded. Effects that remained significant (Table 6) even after the variables listed in Table 5 were included were ethnicity and delivery at home. Judging from the scatter diagram and the small value of the goodness of fit chi-square ($X^2 = 0.976$ with two de-

Table 6. NNT mortality odds ratios (OR) indicated by the case-control study for home delivery and Mexican Indian race. Both birthplace and ethnicity are in the model.

	OR, crude	(95% CI)*	OR, adjusted	(95% CI)†
Home delivery	9.6	(2.3, 55.5)	7.3	(1.9, 28.8)
Mexican Indian race (e.g., Náhuatl, Otomí)	8.4	(1.9, 33.0)	5.0	(1.3, 18.8)

*Fisher's exact CI.
†Logistic model, MLE's CI.

grees of freedom, *P* value of 0.614), these values fit the logistic model. Although the effect of toxoid vaccination was found to be of borderline significance when considered alone, it failed to remain significant after the other major risk factors were included. The unadjusted estimate of vaccine efficacy (for 2+ doses of tetanus toxoid) was 70% (CI = 52–100%).

DISCUSSION

This is the second largest probability survey of NNT in Mexico, and the first such survey providing an NNT estimate for an entire state. It appears from the data obtained that the actual number of NNT deaths occurring in the State of Veracruz could be exceeding the number reported by a factor as great as 50. This estimate is consistent with a recently conducted NNT survey of hyperendemic municipalities in the State of Jalisco (10).

It has been suggested by other researchers that our study's survey method consistently underestimates the number of deaths, because it only provides a direct assessment and is strongly influenced by the length of the recall period (22, 23). The trend depicted in Figure 1 suggests that this limitation exists in our data. Certain other methods, such as monitoring or assessing pregnancy outcomes, have been able to provide more accurate detection of neonatal deaths. However, it should also be noted that the neonatal mortality found by our Veracruz study is greater than that found by NNT mortality surveys conducted in various

other places such as Côte d'Ivoire, Indonesia, and Burma (22, 24, 25).

Data from other Veracruz surveys also suggest our survey may have undercounted deaths (especially neonatal deaths) more than live births. In particular, data from the National Health Survey (1987) (5) and the Demographic and Health Survey (1987) (26) lead to an estimate of 60 infant deaths annually per 1 000 live births in the State of Veracruz during the period from 1982 to 1987, a point estimate that considerably exceeds our own point estimate (25 deaths per 1 000 live births) and its 95% confidence interval (CI = 18.8, 31.0). Therefore, we suspect that our study's figures provide only a minimal estimate of the NNT problem's true magnitude.

Another study limitation arises because only half (13) of the 26 reported cases were included in our case-control study. This could have introduced a selection bias if cases included in the study confronted a different mix of exposure variables than those excluded. The main reason for excluding cases was their location in the more remote villages. Therefore, any differences between the included and excluded cases probably tended to cause underestimation of the observed risk factors' impact (see Table 5).

In addition, a misclassification bias might have been introduced by inadequate assessment of the cause of death (i.e., if some of our cases were not really NNT deaths). This bias would likewise have tended to cause underestimation of the strength of the associations detected,

while at the same time tending toward overestimation of NNT mortality.

Our vaccine efficacy estimates (see Table 5) may also represent an underestimate. The statistical model of Greenwood and Yule that we employed, although developed for typhoid fever, has dealt mainly with diseases transmitted directly from person to person.

Because the reservoir of *Clostridium tetani* is soil, controlling for exposure to tetanus infection is a complex challenge to Mexican public health in its efforts to provide basic prenatal health care and safe delivery conditions for all women. So far as our study findings are concerned, it appears that the number of missed opportunities for tetanus toxoid vaccination was the same for cases and controls, which suggests that the vaccination program against NNT in the State of Veracruz needs to be modified to identify and focus efforts upon groups at high NNT risk. More generally, it is worth noting that while universal access to basic perinatal health care has not yet been proven feasible, it should be affordable for a developing nation in Mexico's position.

In our study, it appears that the type of birth attendant present served as a proxy for poverty. The picture is not improved by physician distribution, because there are currently about 12 000 unemployed physicians in Mexico's large cities (27) and an approximately equal number of unemployed nurses. Meanwhile, tens of thousands of NNT deaths are occurring as a result of deliveries outside hospitals, often on dirt floors, by mothers receiving little or no prenatal care and no tetanus toxoid. It seems clear that resources should be distributed so as to provide more equitable health care.[3]

Our sample survey and case-control findings can be combined to estimate the percentage of NNT deaths that might be prevented by improving primary perinatal health care. Overall, our data indicate a rate of approximately 3 NNT deaths per 1 000 live births, with NNT mortality being substantially lower (2 versus 5 deaths per 1 000 live births) among those whose births were attended by a physician or nurse as compared to a traditional attendant or other nonprofessional. Since approximately 40% of all deliveries are attended by traditional birth attendants or other nonprofessionals, our data yield a population-attributable risk estimate of 1.2 NNT deaths per 1 000 live births (28).

These results imply that 40% of all NNT deaths could be prevented by providing access to birthing settings (including notably cleaner birthing places) attended by physicians and nurses. However, the fact that 9 (35%) of the 26 NNT deaths occurred to neonates whose births were attended by a physician or nurse (see Table 3) also raises questions about the quality of professional health care. The large number of missed opportunities for tetanus toxoid vaccination during prenatal visits (see Table 5) further highlights inadequacies of the health care system.

Overall, this study provides data that support launching a major effort in the perinatal health care field, especially among Mexican populations at high NNT risk such as Mexican Indians and the uninsured. Measures called for include (1) comprehensive training of traditional birth attendants (acknowledging the limitations of the usual methods for training birth attendants in Mexico—29); (2) wider immunization coverage with tetanus toxoid; (3) increased enrollment of pregnant women in prenatal care programs; (4) provision of clean birthing places in rural areas; and (5) education of both pregnant women and birth attendants (including

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health professionals) regarding proper birthing practices.

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Congress on Alcohol and Drug Dependence

The 37th International Congress on Alcohol and Drug Dependence will be held in San Diego, California, on 20–25 August 1995, under the auspices of the International Council on Alcohol and Addictions (ICAA) and hosted by the University of California, San Diego. Some 2 000 delegates are expected to attend. The official languages of the Congress are English, French, and Spanish, and simultaneous translation will be provided.

The theme of the Congress is "building global bridges"—nations and communities sharing research and strategies to reduce problems related to the use of alcohol, tobacco, and other drugs. Among the objectives is to explore the ways in which different cultures view and respond to addiction problems.

Registration for the entire Congress costs US$ 525 (US$ 420 for ICAA members); the daily registration rate is US$ 125. For further information, contact either of the following:

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