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A method for adjusting gender bias in neonatal tetanus reports in Egypt 1991

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SUMMARY

Reports of neonatal tetanus (NT) disease, common in developing countries, often suffers from gender bias because male infants are brought to health facilities while females are attended at home. Using existing health data we applied reasonable assumptions to estimate the true incidence of NT economically. To adjust for gender disparities in national reporting, we ignored the number of female NT cases and doubled the number for males. Governorates with similar demographic risk profiles for NT were assigned to one of six groups. The highest incidence rate within the group was determined and applied to the number of live births represented by the group. Other internal data comparisons were done to support our estimate that the male:female ratio of NT incidence was far less than the reported 4·12:1. In 1991, the male:female ratio of NT cases was 4·12:1. Decreasing the male:female ratio to 1:1 decreased sensitivity to a 62% estimate. Further adjusting for assumed under-reporting by governorates based on population profiles yielded a reporting sensitivity of 40%. Estimated male and female age-specific NT mortality rates from available data supported the assumption that NT mortality ratios are less than 4·12:1. This report, therefore, describes a unique, economical method to estimate the incidence of a disease assumed to be affected by gender biases in the reporting system. The method relies on two assumptions: that the true NT male:female ratio is close to 1:1 and that populations with similar demographics within a country should have similar incidence rates of NT.

INTRODUCTION

Neonatal tetanus infection typically occurs when the neonate is infected with *Clostridium tetani* often from herb, oil, manure or other types of poultices traditionally applied to the umbilical cord/stump immediately after birth or through unclean birthing practices. Once infected, the child becomes ill and often dies within 4–14 days of age from tetanus toxemia. In nearly all field studies, the incidence of the disease is approximately equal for both sexes [1]. However, passive government surveillance reports in developing countries typically collect very limited information and show disparate male to female ratios with some studies being higher than 10:1 [2]. Although no definitive explanation for these disparities in reporting exists, it is speculated that due to extremely limited resources male neonates are preferentially brought to government facilities, while females are treated at home or by traditional healers and thus those cases are unreported.

Cases of NT are reported to the Egyptian national surveillance system when patients are diagnosed at district 'fever' hospitals. The fever hospitals are referral facilities for infectious diseases. According to

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national policy, all neonates with suspected NT seen at government health facilities are referred to a fever hospital. Sick neonates may also be seen by private practitioners who are obligated to report NT but might not refer the patient to a fever hospital. All reports of NT are sent to district health offices, which report to the 26 governorates. The governorates, in turn, compile the reports and send them to the national Ministry of Health in Cairo. Beginning in 1991, all reported cases of NT were investigated to confirm the diagnosis. The sensitivity of case reporting has been questioned on the following two levels.

(1) It was suspected that female NT cases were under-reported since the male:female ratio was 4·12:1 and community-based surveys specifically conducted to measure mortality attributable to NT showed the incidence by sex to be closer to 1:1 [4, 5].
(2) Patients seen exclusively by traditional healers, or who never receive medical assistance, would not be detected and reported [3].

Since there was concern about reporting accuracy, the Child Survival Project (CSP) desired a rapid and economical method to estimate the sensitivity of NT reporting by reviewing the limited data that is routinely collected to better estimate the true incidence of neonatal tetanus.

METHODS

Adjustment for the presumed under-reporting of female cases

Based on previous neonatal tetanus studies [1, 2, 4, 5] and knowledge that female cases have traditionally been under-reported in Egypt and other developing nations [2, 6] and no known gender-based survival is known to exist for NT [12], we assumed that the true male-to-female case ratio was 1:1. Since all governorates reported more male than female cases we also assumed that reporting male NT deaths was a more accurate measure of true incidence than reporting of female cases. Consequently, the first step of the calculation of reporting sensitivity was to discard the number of female cases reported and double the number of male cases for every governorate that reported cases. We believe that male cases were not over-reported because during 1991 all cases of NT reported to the Ministry of Health were secondarily investigated by a local physician and confirmed. (NB: Since investigated cases which did not meet the case definition were discarded by the ministry, it was not possible to evaluate the positive predictive value of reported NT.)

Adjustment for governorate risk profiles and reporting differences

To account for differences in reporting among governorates with similar risk profiles, all governorates were grouped by location within Egypt (Table 1). The traditional regions, upper (southern) Egypt, lower (northern) Egypt, and desert, were used for grouping the governorates, and are economically and culturally different from each other [7, 8]. Each governorate was assigned to a group based on traditional classifications as being either urban or rural (defined as having more urban or rural districts within the governorate designated by municipal zoning), and by tetanus toxoid (Td) coverage rates among pregnant women, estimated by the Child Survival Project. Seven of the 26 governorates could not be grouped using these criteria and were placed in the 'not classified' group. An example of this problem is illustrated by the Aswan governorate where the cultural practices, Td coverage and drastically mixed urban and rural areas make it unique on a governorate level. Therefore, the incidence rates of NT for these governorates is not linked to a similar 'key' governorate believed to have more accurate reporting.

The incidence rate of NT for every governorate was calculated based on doubling the number of reported male cases divided by the total number of live births within that governorate. Within the demographically similar groups of governorates the highest incidence rate for NT was applied to the cumulative total of live births for the group. The intent of this calculation was to account for poor reporting from governorates as was suspected by the Ministry of Health. Egyptian epidemiologists verbally concurred that the governorates with the highest incidence rates for NT, as determined with our methods, were also the same ones believed to provide the Ministry with the most accurate reports in their opinion. The estimated cases of NT in Egypt was the sum for all groups of governorates using these calculation adjustments.

Sensitivity of reporting

Sensitivity of reporting was estimated by dividing the number of cases reported by the number of cases estimated to have occurred after adjusting for under-reporting by gender and governorate risk profile.

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Table 1. *Estimated rate of NT per 1000 live births, based on twice the number of reported male cases, Egypt 1991*

Group description	Governorate	Reported male cases of NT	Double the reported male cases of NT	Est. number of live births	Est. rate of NT per 1000 live births
Lower Egypt, urban,	Alexandria*	61	122	78083	1·6
Coverage of 61–70%	Cairo	38	76	147022	0·50
	Ismalia	13	26	18802	1·40
	Port Said	0	0	8895	0·00
Lower Egypt, rural,	Behiera*	211	422	113777	3·70
Coverage of 61–70%	Kafr El-Shiekh	70	140	63339	2·20
	Damietta	5	10	23877	0·40
	Gharbia	45	90	91659	1·00
	Sharkia	137	274	118803	2·30
Upper Egypt, rural,	Sohag*	384	768	113491	6·80
Coverage of 51–60%	Beni Suif	138	276	64009	4·30
	Fayoum	77	154	61398	2·50
	Qena	145	290	91387	3·20
Upper Egypt, rural,	Assuit*	374	748	96474	7·80
Coverage of 71–80%	Giza	77	154	129390	1·20
Desert communities	North Sinai*	7	14	6139	2·30
all rural, Coverage of	Red Sea	0	0	2647	0·00
71–80%	New Valley	0	0	3522	0·00
	Matruh	2	4	6924	0·60
Not classified	South Sinai	0	0	786	0·00
	Miniya	254	508	117076	4·30
	Suez	7	14	11455	1·20
	Menoufia	51	102	68231	1·50
	Dakahalia	47	94	114956	0·80
	Kalyoubia	39	78	76322	1·00
	Aswan	14	28	27594	1·00
Totals		2196	4392†	1656058	2·70

* Indicates highest rate in the group.
† Represents minimum number of estimated cases.

Supporting the assumption that the true male:female NT case ratio is less than 4:1

To evaluate the assumption that the incidence rates of NT for females should be close to that of males, we used a standard formula to estimate the number of NT deaths by gender from vital registry data [9, 10]. We then determined the rate per 1000 live births for the years 1987 and 1988 (vital registry data were not available for the years after 1988). Death registration is required by law and is reported through a different system than data reported by fever hospitals. The number of NT deaths was estimated based on calculations from previous studies [9, 10] which indicated that, in the absence of NT, the average mortality rate per day for neonates 4–14 days would be approximately 1·5 times the average mortality rate per day for neonates 15–28 days. The average mortality rate per day for 15–28 days of age was multiplied by 1·5 and subtracted from the same average for 4–14 days of age, then multiplied by 11 to estimate deaths attributable to NT. Based on the belief that 90% of all deaths caused by NT occur at 4–14 days of age [11]. The number of deaths attributed to NT was then divided by the number of reported live births and multiplied by 1000. Mortality rates per 1000 live births by gender were compared to test the assumption that male and female neonates are equally at risk for NT.

RESULTS

A total of 2726 cases of NT were reported in Egypt in 1991, for an incidence rate of 1·6 per 1000 live births. There were 530 female cases and 2198 male cases reported. The incidence rates in governorates that was calculated by doubling the number of mate cases are shown in Table 1. The sensitivity of reporting,

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Table 2. *Estimated cases of NT based on highest rate within groups of governorates, Egypt, 1991*

Group description	Estimated number of live births in group	Highest rate per 1000 live births in group	Estimated cases of NT for group
Lower, urban	252802	1·6	404
Lower, rural	411455	3·7	1522
Upper, rural, 51–60% coverage	330285	6·8	2246
Upper, rural, 71–80% coverage	225864	7·8	1762
Desert communities	19232	2·3	44
Not classified	416420	NA	824
Totals	1656058	4·10	6802

NA, not applicable.

Table 3. *Derivation and comparison of NT mortality rates by sex, Egypt 1987 and 1988*

Sex	Average deaths per day (4–14)	Average deaths per day (15–28)	Estimated NT deaths during 4–14 days*	NT mortality rate†	M:F ratio
1987					
M	688	133	5373·5	5·5	5·5:2·9 or 1·89:1
F	433	124	2717	2·9	
1988					
M	821	154	6490	6·6	6·6:2·9 or 2·27:1
F	456	136	2772	2·9	

* Calculated as (4–14 day deaths $-$(15–28 day deaths) $\times$ 1·5) $\times$ 11.
† Calculated as (NT deaths per day during 4–14 days/number of live births) $\times$ 1000.

adjusted only for the under-reporting of female cases was: (2728 cases reported/4392 cases estimated) $\times$ 100 = 62%.

Table 2 shows the number of cases adjusted for both sex and reporting differences among governorates with similar risk profiles. The sensitivity of case reporting was: (2728 cases reported/6802 cases estimated) $\times$ 100 = 40% sensitivity.

To test the assumption that the male-to-female ratio is less than 4:1, the estimated number of NT deaths during 1987 and 1988 for neonates of aged 4–14 days and the associated mortality rates are compared in Table 3. In both cases the male to female ratio is far less than the 4:1 ratio being reported through the fever hospitals. The estimated sensitivity of 40% suggests that 2·5 NT cases occur in Egypt for each case reported to the Ministry of Health.

DISCUSSION

In many developing countries poverty and the paucity of health resources force parents to make difficult decisions when a child falls ill. Because many higher level health facilities may charge a fee or cause a parent to miss work or be away from the household, male children, felt to be more valued in society, who fall ill, are preferentially brought to such facilities [2, 3, 6]. In addition, Ministries of Health are forced to allocate resources often based on very limited or poorly collected information. Since data collection, especially field studies, can be expensive, the method described in this paper offers one possible estimate of true incidence rates using routinely collected data for the Egyptian Ministry of Health.

Community-based mortality surveys are probably the best means of obtaining data to evaluate routine reporting of NT. In order to be precise and accurate, such surveys are necessarily large and expensive. In contrast, the method here uses internal comparisons of routinely collected data, and provides a less expensive means for estimating the sensitivity of NT reporting. Knowledge of the sensitivity of NT reporting can be used to improve surveillance, evaluate impact, and facilitate decisions concerning health resource allocation.

There are several potential sources of error that may have affected our estimate of NT reporting sensitivity. First, our estimates of the sensitivity of reporting do not take into account male cases which

may have gone undetected in the governorates with the highest reported rates for males. If unreported mate NT cases had been detected and included, that would have increased the total number of male cases even further and further decreased the estimated sensitivity of reporting. Second, if the highest reported rate of NT among male newborns within each group of governorates was higher than the true rate for the governorates in the group as a whole, the sensitivity of reporting would be higher than our estimate. Third, the true male : female NT incidence ratio, in Egypt, may be somewhat higher than 1. In this case, our assumption of a 1 : 1 incidence ratio would have led to an underestimate of reporting sensitivity. As mentioned previously, over-reporting of male NT cases was unlikely since all NT cases in Egypt, during the time period studied, were investigated by local doctors through a procedure established by the Ministry of Health.

The assumption that the male : female ratio of NT cases should be close to 1 : 1 is supported by other investigations concerning risk factors that predispose neonates to *C. tetani* infection [12, 13] and by our review of the 1987 and 1988 Egypt neonatal mortality data. Current knowledge of *C. tetani* infections indicates no differential infective or mortality biases based on sex [12]. In industrialized countries such as the United States, the male : female incidence ratio for the disease has been approximately 1 : 1 [14]. Male circumcision has been suggested as the reason for a higher incidence of NT in males, but, in Egypt, the procedure is not done until the sixth week of life, with few exceptions [3]. Estimates of neonatal mortality by sex (Table 3) from the vital registry data indicate that the rate of death caused by NT among females is only about half the rate among males. The male : female NT mortality ratios from vital registry data were not used to estimate the sensitivity of reporting cases because those data do not include neonates who survived the disease. The rate ratios were calculated only to evaluate the assumption that the reported male : female NT incidence rate ratio of 4 : 1 should be closer to 1 : 1. We do not know if the roughly two times higher mortality rate for males in the vital registry data reflect a true difference in mortality by sex. In the absence of another explanation, we have chosen to assume that the true ratio is 1 : 1.

Several studies that correlated the incidence of NT to rural settings, high use for traditional birth attendants, and low tetanus toxoid coverage among women, as well as other factors [10–13], were the basis for grouping governorates by risk profiles. The assumption that the governorate in each group with the highest rate of NT had a more accurate reporting system than the other governorates in the same group is supported by investigations of non-polio acute flaccid paralysis used as an indicator for reporting accuracy by the polio eradication programme. Non-polio acute flaccid paralysis was more accurately reported by the governorates with the highest incidence of NT (shown in Table 2) than other governorates within the same group with the exception of North Sinai [15].

The estimate of sensitivity of reporting might be improved by grouping at the level of districts instead of governorates. Governorates classified as urban or rural contain districts that vary greatly in their risk profiles for NT. Further study is needed to determine the actual male-to-female incidence ratio. A more accurate estimate of the male-to-female neonatal mortality ratio might be calculated using vital registry data from the year 1991 and should be done if these data become available. Future studies should target the governorates with highest incidence using field data cluster survey analysis to confirm our estimated rates.

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