ABSTRACT

Purpose: To assess the regional patterns of infant mortality due to lethal congenital anomalies, and the potential reasons for the regional patterns.

Method: The study analyzed 2,507 infant deaths due to lethal congenital anomalies among 1,178,452 live births in 9 of the 12 Canadian provinces and territories from 1990 to 1995 recorded in Statistics Canada's live birth and death data bases.

Results: Compared with the province of Quebec, congenital anomaly-attributed infant mortality was higher in Newfoundland, Saskatchewan, and Alberta. These differences in infant mortality were substantial for cardiovascular system anomalies and especially anencephaly. For infant mortality due to chromosomal anomalies, however, there was little interprovincial variation.

Conclusions: Despite substantial recent reductions in lethal congenital anomaly-attributed infant mortality, there remain major regional variations in infant mortality caused by certain forms of congenital anomalies including anencephaly and cardiovascular system anomalies.

ABRÉGÉ

But : évaluer les tendances régionales de mortalité infantile attribuable aux anomalies congénitales mortelles, et les raisons potentielles qui les expliquent.

Méthode : l'étude a analysé 2 507 décès de nourrissons résultant d'anomalies congénitales mortelles sur 1 178 452 naissances vivantes dans 9 des 12 provinces et territoires du Canada, de 1990 à 1995, à partir des bases de données sur les naissances vivantes et les décès à la naissance de Statistique Canada.

Résultats : par comparaison avec la province du Québec, la mortalité des nourrissons attribuable à des anomalies congénitales est apparue plus élevée à Terre-Neuve, en Saskatchewan, et en Alberta. Ces écarts de mortalité infantile étaient très nets pour les anomalies du système cardio-vasculaire, et spécialement dans les cas d'anencéphalie. Toutefois, en ce qui a trait à la mortalité infantile attribuable aux anomalies chromosomiques, on a constaté peu de différences entre les provinces.

Conclusions : en dépit d'une nette baisse récente de la mortalité infantile attribuable aux anomalies congénitales mortelles, il subsiste des écarts régionaux de mortalité infantile causée par certains types d'anomalies congénitales, notamment celles dues aux anencéphalies et aux anomalies du système cardio-vasculaire.

Regional Patterns of Infant Mortality Caused by Lethal Congenital Anomalies

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Our previous study[1] found that infant mortality due to lethal congenital anomaly decreased from 3.11 per 1,000 live births in 1981 to 1.89 per 1,000 live births in 1995 (data available upon request). Infant deaths attributable to lethal congenital anomalies (as a percentage of total infant deaths) fluctuated between 30% and 34% during the same period of time in Canada (data available upon request). This is contrary to the findings of earlier studies (carried out in 1960s and 1970s) which showed that the rate of infant deaths due to lethal congenital anomalies remained stable and the percentage of infant deaths attributable to lethal congenital anomalies was increasing over time.[2,3] We hypothesized that the patterns of lethal congenital anomaly-attributed infant mortality have changed in recent years, mainly because infant deaths caused by certain lethal congenital anomalies, such as anencephaly, spina bifida, and cardiovascular system anomalies, are now being reduced because of advances in perinatal care including prenatal diagnosis and early surgical repair.

Perinatal care policy and quality vary across regions, even within the Canadian health care system with universal access to essential services. For example, regional differences in perinatal care regionalization, availability of special care facilities, and distance between patient's residence and special care facilities could result in differences in access to special care. The attitude of the family and local community (e.g., attitude towards pregnancy termination) also plays an important role. Regional differences in perinatal care policy and quality could therefore affect the regional pattern of infant mortality caused by lethal congenital anomalies. This study aims to examine regional patterns of infant mortality caused by lethal congenital anomalies, by analyzing the province-specific congenital anomaly-attributed infant mortality in Canada between 1990 and 1995.

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SUBJECTS AND METHODS

We used the 1990 to 1995 Statistics Canada's live birth and death data bases, which contain information on all live births and deaths in Canada during that period of time. Births and deaths from British Columbia were not included in the analysis because at the time we were denied access to this province's data. Ontario was also excluded because of concerns regarding data quality.[4,5]

We hypothesized that regional differences in perinatal care policies and quality may have impacted differently on different categories of congenital anomaly. To test this hypothesis, we divided the lethal congenital anomaly into six categories: anencephalus and similar anomalies (ICD-9 740), spina bifida (ICD-9 741), central nervous system anomalies other than anencephaly and spina bifida (ICD-9 742), cardiovascular system anomalies (ICD-9 745, 746, 747), chromosomal anomalies (ICD-9 758), and all congenital anomalies (ICD-9 740-759). Province- and cause-specific infant mortality rates for the abovementioned six categories of congenital anomalies were estimated. Relative risks (and 95% confidence intervals) were then calcu-

lated for each province, with Quebec as the reference. The choice of the reference group was based on the fact that Quebec has the largest number of births and the lowest infant mortality rate among the provinces studied.[5]

Only the underlying cause of death is recorded in Statistics Canada's death registry data and this is coded using the ICD-9 classification system. We assumed that only lethal congenital anomalies would have been coded as the underlying cause of death, because for minor congenital anomaly, another disease should have been coded as the underlying cause. However, we did consider the possibility that some minor congenital anomalies were erroneously coded as the underlying cause of death. We were also concerned about potential differences in the frequency of coding errors across provinces. Accordingly, we examined the actual ICD-9 codes for all of the infant deaths with an underlying cause of death as congenital anomaly (ICD-9 740-759) for each province.

RESULTS

Between 1990 and 1995, a total of 7,779 infants died before one year of age in 9 of the 12 provinces and territories of Canada, giving an overall infant mortality rate of 6.60 per 1,000 live births. Two thousand five hundred and seven (2,507) infant deaths were attributed to lethal congenital anomalies, giving a lethal congenital anomaly-associated infant mortality rate of 2.13 per 1,000 live births.

Compared with the province of Quebec, congenital anomaly-attributed infant mortality was statistically significantly higher in Newfoundland, Saskatchewan, and Alberta (Table I). The difference in infant mortality was substantial for cardiovascular system anomalies and especially for anencephaly. For infant mortality due to chromosomal anomalies, however, there was little inter-provincial variation (Table I). For example, compared with the province of Quebec, infant deaths in Newfoundland were 6.52 (95% CI 3.26, 13.1) times higher for anencephaly, 1.42 (95% CI 0.69, 2.94) times higher for central nervous system anomalies other than spina bifida and anencephaly, 1.75 (95% CI 1.28, 2.39) times higher for cardiovascular system anomalies, and 1.85 (95% CI 1.53, 2.24) times higher for all congenital anomalies. Infant deaths due to spina bifida were 0.86 (95% CI 0.27, 2.74) times as high in Newfoundland as compared with Quebec, while those due to chromosomal anomalies were 0.90 (95% CI 0.42, 1.92) times as high (Table I).

Possible coding errors (minor congenital anomaly coded as underlying cause of death) accounted for less than 1% of infant deaths attributed to congenital anomalies in all provinces and territories studied.

DISCUSSION

Our study demonstrates major regional differences in lethal congenital anomaly-attributed infant mortality in Canada. Moreover, the inter-provincial variation in lethal congenital anomaly-attributed infant mortality varied according to category of congenital anomaly. For infant mortality caused by cardiovascular system anomalies and (especially) anencephaly, the inter-provincial variations were substantial, whereas for infant mortality caused by chromosomal anomalies, there was no inter-provincial variation.

Our study has several potential limitations. The data used in this study were extracted from death certificates which record an underlying cause of death. Errors can occur in assigning the cause of death and in coding. Moreover, the underlying cause of death in this data set was coded using the ICD-9 system, which may not be adequate for certain congenital anomalies.[6] Nevertheless, apparent coding mistakes such as minor congenital anomaly coded as an underlying cause of death were rare in the data.

Regional differences in maternal exposure to environmental teratogens, genetic predisposition, and primary prevention strategies could result in regional differences in the incidence of major congenital anomalies which, in turn, could result in regional differences in lethal congenital anomaly-attributed infant mortality. Numerous studies aimed at identifying environmental teratogens have been conducted in the past several decades, but well-established teratogens are few.[7] There is evidence suggesting that folic acid and other vitamin supplementation prevents neural tube defects[8-11] and some other forms of congenital anomalies,[12,13] however, its impact in the general population remains undetermined. Since our data did not include maternal exposure, population profile, and prevention information, it is not possible for us to assess the impact of potential regional differences in maternal exposure, genetic predisposition, and primary prevention on the observed regional patterns of lethal congenital anomaly-attributed infant mortality.

Analysis by specific category of congenital anomalies can help in the interpretation of the data, as it allows an assessment of the biological plausibility of the observed variations. Regional difference in prenatal diagnosis with subsequent termination of affected pregnancies is probably the main reason for the substantial regional difference in infant mortality caused by anencephaly. This anomaly is diagnosed early in pregnancy and the chance for pregnancy termination is high once the diagnosis is established.[14,15] It has been demonstrated that there are major regional differences in the rate of prenatal diagnosis for anencephaly and also in termination rate following such diagnosis.[14,15] Observed regional differences in the birth prevalence of neural tube defects has been shown to be attenuated or abolished when therapeutic abortion data were accounted for in the analysis.[14] Regional differences in timing and quality of surgical repair for spina bifida and cardiovascular system anomalies may also have played a role in the observed regional differences in infant mortality attributed to spina bifida and cardiovascular system anomalies. Studies have demonstrated that early surgical repair can significantly improve the survival of infants affected by these two categories of anomalies.[16,17]

For major chromosomal anomalies, there exist relatively objective criteria for diagnosing and classifying karyotypic anomalies.[7] Many chromosomal anomalies are not amenable to surgery. Although prenatal diagnosis for this anomaly is possible, the likelihood of subsequent termination of the affected fetus is less than for other anomalies such as anencephaly. As a result,

TABLE I
Comparison of Infant Mortality Due to Lethal Congenital Anomalies Among Canadian Provinces and Territories, 1990-95

	Quebec*	NF	PEI	NS	NB	MB	SK	AB	YK & NWT
Anencephaly:									
Number of deaths	29	11	2	5	6	8	7	26	1
Rate (per 1000)	0.05	0.34	0.18	0.07	0.11	0.08	0.08	0.11	0.08
Relative risk	1.00	6.52	3.53	1.38	2.10	1.54	1.54	2.04	1.58
95% CI		3.26, 13.1	0.84, 14.8	0.53, 3.51	0.87, 5.06	0.71, 3.37	0.67, 3.51	1.20, 3.47	0.21, 11.4
Spina bifida:									
Number of deaths	60	3	0	6	7	6	2	12	0
Rate (per 1000)	0.11	0.09	0.00	0.09	0.13	0.06	0.02	0.05	0.00
Relative risk	1.00	0.86	0.00	0.80	1.19	0.56	0.21	0.46	0.00
95% CI		0.27, 2.74	0.00	0.35, 1.85	0.54, 2.59	0.24, 1.29	0.05, 0.81	0.25, 0.85	0.00
Other central nervous system anomalies:									
Number of deaths	97	8	3	9	11	13	29	48	5
Rate (per 1000)	0.17	0.24	0.27	0.12	0.20	0.13	0.33	0.19	0.40
Relative risk	1.00	1.42	1.58	0.74	1.15	0.75	1.91	1.13	2.33
95% CI		0.69, 2.94	0.50, 5.00	0.38, 1.47	0.62, 2.15	0.42, 1.34	1.21, 2.88	0.88, 1.59	0.95, 5.72
Cardiovascular system anomalies:									
Number of deaths	432	44	7	61	30	83	59	234	14
Rate (per 1000)	0.77	1.35	0.64	0.87	0.54	0.83	0.67	0.95	1.13
Relative risk	1.00	1.75	0.83	1.13	0.71	1.07	0.87	1.23	1.47
95% CI		1.28, 2.39	0.39, 1.75	0.87, 1.48	0.49, 1.02	0.85, 1.36	0.66, 1.14	1.05, 1.45	0.86, 2.49
Chromosomal anomalies:									
Number of deaths	134	7	2	11	15	19	27	73	4
Rate (per 1000)	0.24	0.21	0.18	0.16	0.27	0.19	0.31	0.30	0.32
Relative risk	1.00	0.90	0.76	0.06	1.14	0.79	1.28	1.24	1.35
95% CI		0.42, 1.92	0.19,3.09	0.36,1.22	0.67,1.94	0.49,1.28	0.85,1.94	0.93,1.65	0.50,3.65
All congenital anomalies:									
Number of deaths	1075	116	19	125	117	212	219	576	30
Rate (per 1000)	1.91	3.55	1.73	1.78	2.12	2.11	2.48	2.34	2.41
Relative risk	1.00	1.85	0.90	0.93	1.11	1.10	1.30	1.22	1.26
95% CI		1.53,2.24	0.58,1.42	0.77,1.12	0.91,1.34	0.95,1.28	1.12,1.50	1.10,1.35	0.88,1.81

* Reference group

regional differences in perinatal care policy and quality have less effect on infant mortality caused by chromosomal anomalies.

Further major reductions in infant mortality caused by lethal congenital anomalies are unlikely to occur secondary to prenatal diagnosis or surgical repair. Prenatal diagnosis for some forms of congenital anomalies including congenital renal disease and hydrocephalus is difficult, especially in early pregnancy.[18,19] Prenatal diagnosis and subsequent termination of the affected fetus is associated with moral and ethical difficulties,[20] and surgical repair imposes financial and emotional burdens on the family and society.[16] Development of effective primary prevention measures is needed to further reduce lethal congenital anomaly-attributed infant mortality. The substantial regional variations in infant mortality caused by certain forms of lethal congenital anomalies emphasize the need to expand existing surveillance systems to include all affected pregnancies where an anomaly has been detected antenatally, for effective detection of new teratogens and assessment of the impact of primary prevention on congenital anomalies in the general population.

In summary, the analysis of recent Canadian data demonstrates that despite major recent reductions in lethal congenital anomaly-attributed infant mortality, there remain substantial regional variations in infant mortality caused by certain forms of congenital anomalies including anencephaly and cardiovascular system anomalies. These regional variations in lethal congenital anomaly-attributed infant mortality are probably caused by regional differences in perinatal care policy and quality including prenatal diagnosis and subsequent termination and early surgical repair.

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Grippe, de la page 312

En résumé, au tournant du 21e siècle, il va exister davantage de moyens de prévenir et de traiter la grippe, moyens qui vont venir s'ajouter aux progrès des télécommunications qui peuvent servir à mettre en place des réseaux intégrés de communication et de surveillance nationaux et mondiaux. Tout le défi consistera à ne pas se laisser distancer par ces progrès et à bien définir leur rôle dans les programmes de prévention et de lutte contre la grippe.

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