

A B S T R A C T

Purpose: To assess the potential impact of early post birth discharge in Canada.

Methods: Neonatal readmission was examined, based on hospital discharge data from the Canadian Institute for Health Information, with a total of 2,144,205 infants from fiscal year 1989/90 to fiscal year 1996/97.

Results: Neonatal readmission rates increased from 27.3 per 1,000 in 1989/90 to 38.0 per 1,000 in 1996/97, while mean length of hospital stay at birth decreased from 4.2 days to 2.7 days during the same period. The increase in readmission rate was more evident for dehydration and jaundice. The provinces and territories with decreased length of hospital stay at birth usually had increased neonatal readmission rate and earlier age at readmission. Between 1994/95 and 1996/97, compared with Newfoundland, the risks for neonatal readmission for dehydration were 5.7 and 5.5, and for jaundice were 4.5 and 2.7, respectively, for Alberta and Ontario.

Conclusion: Neonatal readmission rates for several conditions have increased substantially, associated with early post birth discharge policies adopted in Canada.

A B R É G É

But : Évaluer l'impact potentiel des sorties précoces de l'hôpital après la naissance.

Méthodologie : Examen des réadmissions néonatales à partir des données sur les sorties d'hôpital fournies par l'Institut canadien d'information sur la santé, portant sur un total de 2 144 205 nouveau-nés, de l'année civile 1989-1990 à l'année civile 1996-1997.

Résultats : Les taux de réadmission néonatale sont passés de 27,3 pour 1 000 en 1989-1990 à 38 pour 1 000 en 1996-1997 alors que la moyenne du séjour à l'hôpital après la naissance passait de 4,2 à 2,7 jours pendant la même période. L'augmentation du taux de réadmission était encore plus marqué pour les cas de déshydratation et de jaunisse. Les provinces et les territoires pour lesquels il y avait diminution de la durée du séjour à l'hôpital après la naissance avaient habituellement des taux de réadmission néonatale plus élevés, et l'âge de réadmission du nouveau-né était inférieur. Entre 1994-1995 et 1996-1997, en comparaison avec Terre-Neuve, les risques de réadmission néonatale pour déshydratation étaient de 5,7 et de 5,5 respectivement pour l'Alberta et l'Ontario; pour la jaunisse, ils étaient de 4,5 et 2,7 respectivement.

Conclusion : Les taux de réadmission néonatale pour certaines affections ont substantiellement augmenté et sont associés à l'adoption au Canada de politiques autorisant des sorties précoces de l'hôpital après la naissance.

Increased Neonatal Readmission Rate Associated with Decreased Length of Hospital Stay at Birth in Canada

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There is an increasing trend towards discharging newborn infants soon after birth. The proportion of newborns discharged within two days after birth increased dramatically from 2.8% in 1984 to 19.1% in 1994 in Canada.¹ In Alberta, this proportion reached 33.5% in 1994.¹ This trend is based on the view that early discharge (i.e., within 48 h after birth) is safe for normal newborns, especially if community follow-up services are provided.²⁻⁶ Moreover, early discharge reduces the health care cost, and may contribute other benefits to the infants and their families.⁷

In a 1996 joint policy statement, the Canadian Paediatric Society and the Society for Obstetricians and Gynaecologists of Canada recommended that discharge of newborns less than 48 hours after birth is appropriate for full term (37 to 42 weeks) infants whose size is adequate for their gestational age and who have no medical complications.⁸ However, according to a previous study, the proportion of low birthweight (< 2500 g) newborns discharged within two days after birth in Canada also rose from 1.4% in 1984 to 6.1% in 1994.¹ This proportion reached 14.9% in Alberta in 1994.¹

Several studies have raised the concern that early discharge of newborns may be associated with an increased health risk.⁹⁻¹² A recent study carried out in Ontario

found that shorter hospital stay at birth was associated with increased neonatal readmission rates for several conditions that may not be manifest within 24-72 hours.⁹ The same study revealed that the severity of jaundice and dehydration in readmitted infants was also shown to have increased in recent years.⁹

Neonatal length of stay has been identified as one of several indicators that are important in perinatal surveillance. The Bureau of Reproductive and Child Health in the Laboratory Centre for Disease Control, Health Canada, is leading the development of the Canadian Perinatal Surveillance System (CPSS). This is the first study by CPSS to evaluate the potential health risk to newborns associated with shorter neonatal hospital stay in Canada. This was done by examining the temporal trends and inter-provincial/territorial variations in neonatal readmission rates using hospital discharge data collected by the Canadian Institute for Health Information (CIHI, formerly Hospital Medical Records Institute).

SUBJECTS AND METHODS

Eight years of CIHI data (from fiscal year 1989/90 to fiscal year 1996/97) were utilized. Data from Nova Scotia, Quebec, and Manitoba were excluded because only a small proportion of hospital discharge records in these provinces were collected by CIHI during the study period.¹³ All live newborns were identified in the dataset.¹³ Newborns whose birthweight was less than 500 grams and those who subsequently died in the birth hospital were excluded. A readmission was defined as the admission of a newborn to any hospital after discharge from the hospital of birth. A new-

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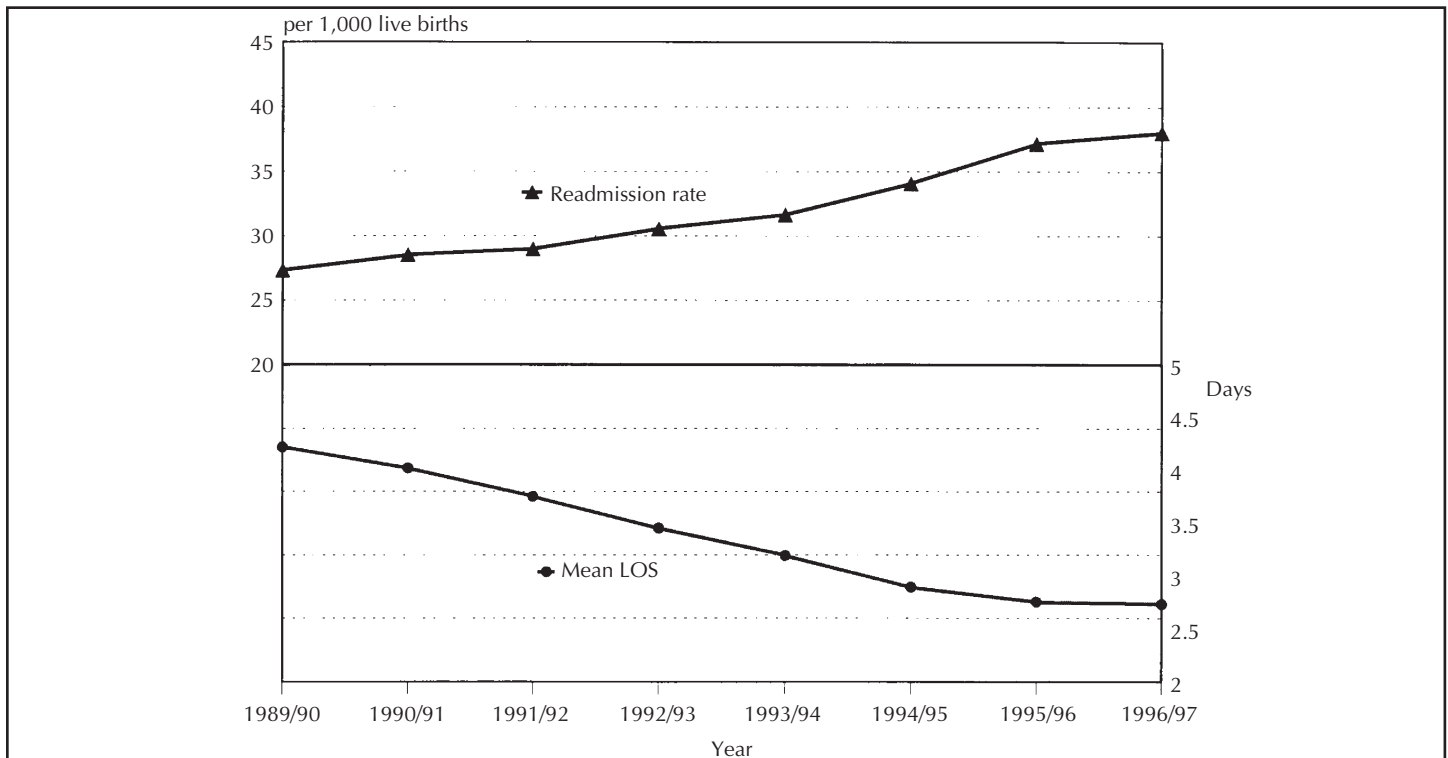


Figure 1. Temporal trends in mean length of hospital stay (LOS, days) at birth and neonatal readmission rate per 1,000 live births, 1989/90 to 1996/97, Canada*

* Source: Canadian Institute for Health Information (CIHI)

born infant transferred directly from another institution was not counted as a readmission. In this study, we focussed on neonatal readmission within (a) 7 days and (b) 28 days of age. Readmission rates were calculated by dividing the number of readmitted newborns in each fiscal year by the number of live births in the same fiscal year. In addition to all-cause readmission, cause-specific readmission rates were also examined for the following five diagnostic categories: jaundice (ICD-9: 773.1, 774.2, 774.3, 774.6, 774.7), dehydration (ICD-9: 276.0, 276.5, 775.5, 778.4), inadequate weight gain (ICD-9: 783.2, 783.4), feeding problems (ICD-9: 779.3, 783.3), and sepsis (ICD-9: 771.4, 771.8). The diagnostic codes were selected from any of the eight diagnosis fields in a readmission record. These diagnostic categories were chosen because they are most likely to be affected by early discharge policies.^{4,9,11} Period comparisons were made after combining data for two fiscal years in order to increase the stability of estimates of cause-specific readmission rates. Relative risks and 95% confidence intervals (CI) were

TABLE I
Readmission Rate (per 1,000 infants) Within 7 Days or 28 Days of Age and Relative Risks for Selected Diagnoses, Canada, 1989-1990 and 1996-1997

Diagnosis	Age (days)	1989-1990	1996-1997	p-value*	RR (95% CI)†
Jaundice	7	3.99	12.21	< 0.001	3.06 (2.91 - 3.21)
	28	7.76	16.44	< 0.001	2.12 (2.04 - 2.20)
Dehydration	7	0.13	1.79	< 0.001	13.50 (10.62 - 17.16)
	28	0.56	3.00	< 0.001	5.36 (4.74 - 6.07)
Inadequate weight gain	7	0.02	0.17	< 0.001	7.63 (4.17 - 13.95)
	28	0.73	1.08	< 0.001	1.48 (1.30 - 1.68)
Feeding problems	7	0.42	3.06	< 0.001	7.33 (6.38 - 8.43)
	28	3.01	6.38	< 0.001	2.12 (2.00 - 2.25)
Sepsis	7	0.24	7.82	< 0.001	3.20 (2.63 - 3.89)
	28	1.29	2.34	< 0.001	1.81 (1.65 - 1.99)
All readmissions	7	7.75	16.71	< 0.001	2.16 (2.08 - 2.24)
	28	27.96	37.19	< 0.001	1.35 (1.32 - 1.37)

* p-values were from Chi-square test for trend from fiscal 1989/90 through fiscal 1996/97 the Mantel Extension Method.

† RR (relative risk) and CI (confidence interval) were calculated by using the rate in 1989-1990 as the reference rate and the rate in 1996-1997 as the index rate.

used to contrast readmission rates between different periods.

To demonstrate whether and to what extent neonatal readmission rates increased as length of hospital stay at birth decreased, yearly average length of hospital stay at birth and neonatal readmission rates in Canada were calculated. Correlations of province-specific average length of hospital

stay at birth with neonatal readmission rates and average age at readmission for period 1989/90 - 1990/91 and period 1995/96 - 1996/97 data were analyzed. Since initial analysis found that neonatal readmission rates based on 28 days of age were comparable with the rates based on 7 days of age, for sample size consideration, only readmission rates within 28 days of

TABLE II
Correlation Between Mean Newborn Length of Hospital Stay at Birth (LOS) and Neonatal Readmission Rate and Mean Age at Readmission Among Canadian Provinces and Territories, 1989-1990 and 1996-1997

Province/Territory	1989-1990			1996-1997		
	LOS at Birth Mean (day)	Readmission Rate per 1,000	Age at Readmission Mean (day)	LOS at Birth Mean (day)	Readmission Rate per 1,000	Age at Readmission Mean (day)
P.E.I.	4.9	11.7	12.9	3.8	18.4	11.2
New Brunswick	4.8	32.1	13.9	3.6	37.8	13.0
Saskatchewan	4.4	36.3	12.6	3.3	44.0	11.2
Newfoundland	4.4	28.1	12.7	3.4	23.4	13.4
Ontario	4.2	24.5	12.6	2.7	35.1	9.9
Alberta	4.0	34.9	11.9	2.4	46.9	8.6
B.C.	3.8	31.9	11.1	2.8	38.2	9.7
Yukon & N.W.T.	3.6	47.7	12.1	2.9	44.2	11.4
CANADA	4.1	27.9	12.3	2.7	37.6	9.9

Source: Canadian Institute for Health Information (CIHI)

Note: 1. Nova Scotia, Quebec and Manitoba were excluded from the analysis because these provinces provided a very small proportion of their data to CIHI.
 2. Correlation coefficient between mean LOS and neonatal readmission rate = -0.69, $p < 0.05$ for 1989-1990; -0.67, $p < 0.05$ for 1996-1997.
 3. Correlation coefficient between mean LOS and mean age at readmission = 0.81, $p < 0.01$ for 1989-1990; 0.78, $p < 0.05$ for 1996-1997.

TABLE III
Inter-provincial Variations in Adjusted Odds Ratios (OR) and 95% Confidence Interval (CI) of Neonatal Readmission for Selected Diagnoses, Canada, 1994/95 to 1996/97*

	NF†	PEI	NB	ON	SK	AB	BC	Yukon & NWT
Jaundice	1.0	1.5(1.0-2.3)	0.9(0.7-1.3)	2.7(2.1-3.3)	3.2(2.5-4.1)	4.5(3.6-5.7)	3.5(2.8-4.4)	1.9(1.3-2.7)
Dehydration	1.0	1.6(0.5-5.1)	1.4(0.7-3.4)	5.5(3.6-8.5)	2.1(1.2-3.6)	5.7(3.7-9.0)	2.3(1.5-3.7)	2.4(0.9-6.2)
Inadequate weight gain	1.0	1.3(0.5-3.7)	1.1(0.6-2.2)	0.9(0.5-1.5)	1.5(0.9-2.8)	1.6(0.9-2.7)	1.3(0.8-2.3)	2.7(1.2-6.1)
Feeding problems	1.0	1.1(0.6-2.1)	1.7(1.1-2.5)	1.6(1.1-2.2)	1.3(0.9-1.9)	1.7(1.2-2.4)	1.3(0.9-1.8)	0.6(0.3-1.4)
Sepsis	1.0	0.7(0.2-1.9)	1.2(0.7-1.9)	1.6(1.1-2.5)	1.2(0.7-2.0)	1.3(0.8-2.0)	1.2(0.8-1.9)	0.7(0.2-1.9)
All readmissions	1.0	1.0(0.8-1.2)	1.5(1.3-1.7)	1.5(1.3-1.6)	1.8(1.6-2.0)	1.9(1.7-2.1)	1.7(1.5-1.8)	1.6(1.3-1.9)

* Source: Canadian Institute for Health Information (CIHI). Total study subjects = 798,840 newborns discharged alive from hospitals within 21 days after birth. Adjusted odds ratios were calculated based on the three-year birth-readmission linked data controlling for birthweight, sex, complications at birth, hospital transfer after birth, year of birth using logistic regression models.

† Reference group.

age were presented in temporal and inter-provincial analyses, and multiple logistic regression analysis.

In order to adjust for differences in baseline characteristics (e.g., birthweight, infant sex, complications at birth, hospital transfer after birth, and year of birth), a linkage of readmission and birth records for fiscal years 1994/95 to 1996/97 was performed. Multiple logistic regression analysis was then performed on the linked data to assess the independent effect of province or territory on neonatal readmission. The linkage was done by matching (determinative) readmission records and birth records on information of infant sex, date of birth, institution code, chart number, health card number and 6-digit postal code of residence using a computer algorithm, supplemented by a logic check of the matched records.¹⁴ Multiple births and those babies whose birthweight was less than 1500 g or for whom initial length of hospital stay at birth was longer than 21

days were excluded prior to linkage. We were able to link 94.2% of readmission records with birth records for the three fiscal years by this linkage procedure. SAS software (SAS Institute, Cary, NC) was used in all analyses and data linkage.

RESULTS

In the eight fiscal years from 1989/90 to 1996/97, a total of 2,149,374 live births were recorded by CIHI in the seven Canadian provinces and two territories. Among them, 2,144,205 live births met the inclusion criteria and were used in the analysis. During the same period, a total of 24,305 infants readmitted within 7 days of age and 68,557 infants readmitted to hospital within 28 days of age were identified among the eligible subjects, giving an overall readmission rate of 11.3 and 32.0 per 1,000 live newborns, respectively, for early neonates (age 1 to 7 days) and neonates (age 1 to 28 days).

Neonatal hospital readmission rates (within 28 days of age) increased from 27.3 per 1,000 in fiscal year 1989/90 to 38.0 per 1,000 infants in 1996/97, whereas mean length of hospital stay at birth decreased from 4.2 days in 1989/90 to 2.7 days in 1996/97 (Figure 1). The overall readmission risks in period 1996-97 were 2.2 and 1.4 times those in period 1989-90 for early neonates and neonates, respectively (Table I). The change in cause-specific readmission rates was more evident for dehydration, jaundice, feeding problems and inadequate weight gain, especially for readmission within 7 days. In 1996-1997, early neonates had 13 or 7 times the risk of being readmitted to hospital for dehydration or feeding problems respectively, compared to those in 1989-1990 (Table I).

Substantial inter-provincial variations in neonatal readmission rates were observed in both periods (Table II). The provinces and territories with shorter average length of hospital stay at birth usually had higher

neonatal readmission rates and earlier neonatal age at readmission in both periods. The correlation coefficients of province-specific neonatal readmission rate with average length of hospital stay at birth (-0.69 in 1989-90 and -0.67 in 1996-97) and mean age at readmission (0.81 in 1989-90 and 0.78 in 1996-97) were statistically significant.

Inter-provincial variations in neonatal readmission for all causes and five selected diagnoses were presented in the form of relative risks (Table III). Compared to Newfoundland, the risks for neonatal readmission to hospital were increased in most provinces or territories. For example, newborns in Alberta had 5.7 and 4.5 times the risk of being readmitted to hospital for dehydration and jaundice within 28 days of age compared to those in Newfoundland, respectively.

DISCUSSION

Our study demonstrates an inverse relationship between neonatal readmission rate and average length of hospital stay at birth. For the seven Canadian provinces and two territories of the study, the average length of hospital stay at birth decreased from 4.2 days in 1989/90 to 2.7 days in 1996/97, whereas the neonatal readmission rate increased from 27.3 per 1,000 infants to 38.0 per 1,000 infants in the same period of time. According to data for period 1989-1990 and period 1996-1997, the provinces and territories with shorter average length of hospital stay at birth usually had higher neonatal readmission rates and younger mean age at readmission. The inference that shorter hospital stay at birth may have resulted in increased neonatal readmission rates is further supported by the fact that the relationship between neonatal readmission rate and average length of hospital stay at birth is the strongest in such diagnostic categories as jaundice and dehydration. These conditions are more likely to be affected by early discharge policies, because they may not manifest at the initial hospitalization, especially if neonates are discharged soon after birth.

Confounding by length of initial hospitalization, although probably substantial for individual cases, may have less impact

on the readmission rates calculated at a country or province and territory level. In our analysis, inter-provincial comparison was based on adjusted odds ratios. The adjustment was performed by multiple logistic regression analysis based on linked birth and readmission records, which did not include babies born outside hospital, or those weighing less than 1500 g at birth, or those whose initial length of hospital stay at birth was longer than 21 days.

Neonatal readmission rates should be taken into consideration in the evaluation of early post birth discharge policies. One of the most important issues is whether and to what extent early discharge has an adverse effect on the health of the infants who subsequently require readmission. A recent study in Ontario found that the severity of jaundice and dehydration in readmitted infants (including 2 deaths associated with hypernatremic dehydration) had increased, probably because of the early discharge policies introduced in recent years.⁹ Although our data were unable to provide detailed clinical and laboratory information about the re-hospitalized infants, one clue that there may have been a detrimental effect on health is the fact that increases in readmission for jaundice and/or dehydration occurred far more frequently at the vulnerable early stages of life (i.e., within 7 days). As well, younger neonatal age at readmission was observed in the provinces and territories with shorter length of hospital stay at birth.

The psycho-social burden on parents resulting from re-hospitalization should also be considered in the assessment of the relative benefits and risks of early discharge policies.

The joint statement of the Canadian Paediatric Society and the Society for Obstetricians and Gynaecologists of Canada recommends that early discharge is appropriate for term infants who meet specified guidelines for health and with appropriate community follow-up.⁸ The joint statement also acknowledges that flexibility taking into account individual circumstances, is necessary in clinical practice. However, a previous CPSS study found that there were substantial increases and major inter-provincial variations in the

proportion of low birthweight (< 2500 g) newborns being discharged within two days after birth.¹ These results suggest that considerable discretion has been used in the decision-making process, and factors beyond clinical judgement may have played an important role.

Several limitations in our data should also be considered in interpreting the results. First, administrative data such as those in CIHI's hospital discharge database usually do not contain detailed clinical information for severity evaluation and are subject to coding errors.^{15,16} Second, we were unable to link 6% of readmitted cases to the birth records due to incomplete information or out-of-hospital births. Third, data on neonatal deaths that occurred outside hospital and health care needs that were met by physicians in their offices or by other community health care personnel were not available for analysis.

Given the fact that early postpartum discharge has been becoming a routine in Canada in recent years, and that this and other studies indicate potential risks of shortened hospital stay on the health of newborns, population-based, systematic studies to examine the balanced benefits and risks of early discharge are needed. These studies should include an evaluation of the role of early discharge community follow-up programs in mitigating the potential risks. Furthermore, hospitals with early discharge policies should work with community health agencies to ensure that guidelines for early discharge are followed. In the mean time, we will continue to monitor the trends and inter-provincial/territorial variations in newborn hospital stay at birth and readmission rates, as part of the national perinatal surveillance mandate.

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