

## An Analysis of Antenatal Hospitalization in Canada, 1991–2003

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**Abstract** *Objectives:* To examine the incidence and temporal trends of hospitalization during pregnancy, and provide additional information on maternal morbidity among Canadian women. *Methods:* A population-based cohort study was conducted using the Canadian Institute for Health Information's Discharge Abstract Database between fiscal year 1991/92 and 2002/03. This database included antenatal

hospitalizations for all hospital deliveries ( $N = 3,103,365$ ) in Canada except for those occurring in Manitoba and Quebec. Temporal trends, and variations in the non-delivery antenatal hospitalization ratio (per 100 deliveries) by maternal age and province or territory were quantified. Primary causes for antenatal hospitalization, the lengths of in-hospital stay, and changing pattern by maternal age and time period were compared. *Results:* The overall antenatal hospitalization ratio declined by 43%, from 24.0 per 100 deliveries in 1991/92 to 13.6 in 2002/03. Younger women tended to be hospitalized more frequently than older women: 27.1 per 100 deliveries for women aged less than 20 years and 21.5 per 100 deliveries for 20–24 years, respectively, compared to 11.5 per 100 for women aged 35–39 years. The antenatal hospitalization ratio varied greatly by province/territory – from 12.2 per 100 deliveries in Ontario to 30.7 in the Yukon. Threatened preterm labour, antenatal hemorrhage, hypertensive disorders, severe vomiting and diabetes remained the five most common causes for antenatal hospitalization, although the trends for the first four declined dramatically from 1991/92 to 2002/03. Younger women were more likely to be admitted for threatened preterm labour and severe vomiting, while older women were more likely to be admitted for antenatal hemorrhage and hypertensive disorders. *Conclusions:* The decline in antenatal hospitalization may reflect changes in management of pregnancy complications, e.g., transition from in-hospital care to out-of-hospital care, and introduction of antepartum home care programs. Information on interprovincial/territorial variations in antenatal hospitalization may be helpful in directing future maternal health care.

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Maternal morbidity includes physical or psychologic conditions, resulting from or aggravated by pregnancy, that adversely affect women's health or that are associated with adverse pregnancy outcomes [1–3]. Hospitalization during pregnancy due to pre-existing conditions or pregnancy complications is an important indicator of maternal morbidity [3–10]. Maternal health status is clearly associated with fetal and child health [3, 5]. Australia (New South Wales) [11] and Ukraine [12] have shown that hospitalization for pregnancy complications (including antenatal hospitalization and hospitalization for early pregnancy loss) are quite common. Of the approximately 4 million deliveries each year in the United States, 8% to 27% of pregnant women are hospitalized at least once prior to delivery [1–3, 7, 13]. Further, non-delivery antenatal hospitalizations (excluding hospitalization for early pregnancy loss) declined from 13.3 hospitalizations for every 100 deliveries during 1991–1992, to 10.5 during 1999–2000 [2]. In Canada, there are over 320,000 deliveries each year, but information on hospitalization during pregnancy is scarce [14, 15].

An important mandate of the Canadian Perinatal Surveillance System is to monitor maternal health status [15]. We have previously reported maternal morbidity during the delivery and puerperal periods (e.g., maternal postpartum readmission) as part of maternal health surveillance and research in Canada [9, 10, 16]. The purpose of the present analysis is to provide additional information on maternal health by examining hospitalizations during pregnancy. We used a large national administrative database to examine the incidence and temporal trends of non-delivery antenatal hospitalization and assess differences by maternal age group and by province/territory.

## Material and methods

The Canadian Institute for Health Information (CIHI) began collecting information on all admissions including day surgeries in most of Canada's acute-care hospitals in the 1980s. CIHI's hospital Discharge Abstract Database (DAD) has been previously used for clinical evaluation, hospitalization and epidemiologic research [17]. Data available from hospital discharge records include demographic and residence information, date of admission, date and status at discharge, principal diagnosis and up to 15 secondary diagnoses. Diagnoses are coded according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9 CM), or the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Canada (ICD-10 CA). Up to 10 procedures are coded according to the Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures (CCP) or the Canadian Classification of Health Interventions (CCI). While ICD-9 CM and CCP were

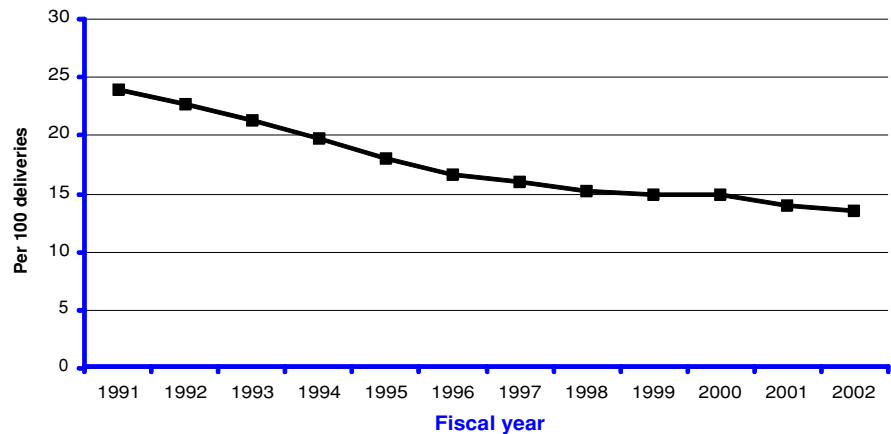
used for coding DAD prior to fiscal year 2000/01, ICD-10 CA and CCI were used for fiscal years 2001/02 and 2002/03.

The present study used DAD data from April 1st, 1991 through March 31st, 2003. Data on hospitalizations occurring in Quebec and Manitoba (approximately 30% of Canadian births) were not included, as complete information on these provinces is not contained in DAD. Data for Nova Scotia were also excluded from the analysis of temporal trends over the period, because they did not become complete until fiscal year 1994/95. DAD includes all hospital deliveries, which account for approximately 98 percent of all births in the study jurisdictions during the study period. Obstetric deliveries are identified using a specified algorithm of diagnostic codes validated by CIHI. We defined antenatal hospitalizations as all hospitalizations in which the woman was pregnant but did not deliver during the hospitalization of interest (i.e., any diagnostic codes from ICD-9 codes 640–676 that have a fifth digit of "3" or any diagnosis in combination with a code of V22 [normal pregnancy] or V23 [high-risk pregnancy]). The unit of analysis was each hospitalization episode; thus, multiple admissions or transfers from another hospital for the same woman during pregnancy were counted as separate hospitalizations. Hospitalizations for early pregnancy loss or elective termination of pregnancy were excluded from this analysis. For the purpose of this study, any hospital discharge record coded as "day surgery" was also excluded.

The antenatal hospitalization ratio is the number of non-delivery hospitalization episodes per 100 hospital deliveries during a specified period. We initially examined the temporal trends in overall antenatal hospitalization ratios between fiscal year 1991/92 and 2002/03. We then examined the antenatal hospitalization ratio by maternal age (less than 20, 20–24, 25–29, 30–34, 35–39 and 40 or more years), and province/territory using data for the most recent two years 2001/02 and 2002/03 (including data for Nova Scotia). We further examined proportions of the leading diagnostic categories comprising the most responsible causes for antenatal hospitalization, and their respective duration of in-hospital stay. Length of in-hospital stay was calculated by subtracting the hospital admission date from the discharge date.

The leading diagnostic categories for antenatal hospitalization were identified using the primary diagnosis field; the second diagnosis field was used only if the first diagnosis was coded as ICD-9 CM 648.93 (other antepartum complication). The 12 single categories were finally selected because each was clearly defined by ICD codes and each diagnosis or group of similar diagnoses accounted for more than 1% of the total antenatal hospitalizations. Included were threatened preterm labour; hypertensive disorders; hemorrhage; severe vomiting; mental disorder; genitourinary complications: intestine, liver or gallbladder disorders; diabetes; cervicals incompetence; known and suspected fetal problems;

**Fig. 1** Ratio of antenatal hospitalization per 100 deliveries, Canada excluding Nova Scotia, Quebec and Manitoba, 1991/92 to 2002/03



premature rupture of membranes; abdominal pain and other causes. Finally, we compared proportions of the five most common diagnostic categories of antenatal hospitalization (i.e., threatened preterm labour, antenatal hemorrhage, hypertensive disorders, severe vomiting and diabetes) by maternal age and examined the temporal change in antenatal hospitalization ratios for these categories between 1991/92 to 1992/93 and 2001/02 to 2002/03. We conducted all analyses using the Statistical Analysis Software package (SAS/STAT User’s Guide, version 8, SAS Inc., Cary, NC).

**Results**

The overall antenatal hospitalization ratio declined by 43%, from 24.0 per 100 deliveries in 1991/92 to 13.6 in 2002/03. The decline was more abrupt in the early 1990s (Fig. 1). Younger women had a higher frequency (risk) of antenatal hospitalization than older women. For example, pregnant women aged less than 20 years were hospitalized (27.1 per 100 deliveries) more frequently than women aged 30–39 years (11.5 per 100 deliveries) during pregnancy. Over three quarters (77%) of the antenatal hospitalizations, however, occurred among pregnant women aged 20–34 years (Table 1).

The overall ratio of antenatal hospitalization to deliveries was 15.1 per 100 in 2001/02 – 2002/03, with a mean length of hospital stay of 2.6 days (standard deviation [SD] 3.5 days). Large differences in ratios of antenatal hospitalization and corresponding lengths of hospital stay were observed among the provinces/territories. For example, far fewer women (12.2 per 100 deliveries) were admitted to hospital during pregnancy in Ontario compared with the Yukon and Newfoundland (30.7 per 100 and 26.7 per 100, respectively). The mean length of stay for hospitalized pregnant women varied from 1.3 days (SD: 0.6 day) in Nunavut to 3.0 days (SD: 4.0 days) in Prince Edward Island. No relationship was apparent between antenatal hospitalization ratios

and length of in-hospital stay among provinces/territories (Table 2).

The 12 leading diagnostic categories (by proportion) of principal causes for antenatal admission and the respective length of in-hospital stay for the combined data for 2001/02 and 2002/03 are shown in Table 3. The top five causes for non-delivery antenatal hospitalization were threatened preterm labour (23.6%), antenatal hemorrhage (10.1%), hypertensive disorders (8.1%), severe vomiting (7.0%) and diabetes (5.8%). Antenatal hospitalizations due to abdominal pain had the shortest duration of in-hospital stay (mean 1.8 days), while women admitted to hospital due to mental disorder or cervical incompetence stayed substantially longer (6.7 and 4.7 days, respectively). Examining the ratios of antenatal hospitalization for the five most frequent categories of primary diagnosis by maternal age showed that younger women were at a higher risk for antenatal hospitalization due to threatened preterm labour and severe vomiting, while older women were at higher risk for hospitalization due to antenatal hemorrhage and hypertensive disorders (Fig. 2).

Corresponding to the declining trend in the overall antenatal hospitalizations, ratios of antenatal hospitalizations

**Table 1** Ratios of antenatal hospitalization per 100 deliveries by age group, Canada excluding Quebec and Manitoba, 2001/02 to 2002/03

Age group	Number of deliveries	Number of antenatal hospitalizations		Ratio per 100 deliveries	
		Number of antenatal hospitalizations	Ratio per 100 deliveries	Proportion	
<20	25,132	6,798	27.1	9.2	
20–24	82,155	17,704	21.5	24.1	
25–29	144,489	21,403	14.8	29.1	
30–34	151,482	17,768	11.7	24.2	
35–39	70,806	8,140	11.5	11.1	
>=40	13,090	1,667	12.7	2.3	
Total	487,154	73,480	15.1	100.0	

Note. Ratio is expressed as the number of non-delivery antenatal hospitalizations per 100 deliveries in the same period.

**Table 2** Ratio of antenatal hospitalizations and length of in-hospital stay (mean  $\pm$  standard deviation [SD]) by province/territory, per 100 deliveries, Canada excluding Quebec and Manitoba, 2001/02 to 2002/03

Province/Territory	No. of deliveries	No. of antenatal hospitalizations	Ratio per 100	Length of stay (mean $\pm$ SD)
Newfoundland	9,097	2,427	26.7	2.9 $\pm$ 4.0
Prince Edward Island	2,616	581	22.2	2.9 $\pm$ 3.3
Nova Scotia	17,197	3,302	19.2	3.0 $\pm$ 4.0
New Brunswick	14,390	2,926	20.3	2.9 $\pm$ 3.7
Ontario	264,390	32,246	12.2	2.5 $\pm$ 3.6
Saskatchewan	23,648	4,980	21.1	2.3 $\pm$ 2.6
Alberta	75,122	13,110	17.5	2.4 $\pm$ 3.2
British Columbia	78,335	13,382	17.1	2.6 $\pm$ 3.8
Northwest Territories	1,424	276	19.4	2.1 $\pm$ 2.4
Nunavut	304	56	18.4	1.3 $\pm$ 0.6
Yukon	631	194	30.7	2.0 $\pm$ 3.1
Total	487,154	73,480	15.1	2.6 $\pm$ 3.5

due to the first four most common causes declined dramatically between 1991/92 to 1992/93 and 2001/02 to 2002/03: threatened preterm labour by 58%; antenatal hemorrhage by 52%; severe vomiting by 49%; and hypertensive disorders by 27%, while admissions for diabetes increased by 10% (Fig. 3).

## Discussion

Canada has witnessed a dramatic decline in the ratio of non-delivery antenatal hospitalization over the past decade, with wide variations in the ratio according to maternal age and province/territory. Younger women were more likely than older women to be hospitalized for antenatal complications, particularly due to threatened preterm labour. Ontario women, representing more than half of the hospital deliveries in this study, experienced the lowest level of antenatal hospitalization among all provinces/territories of study.

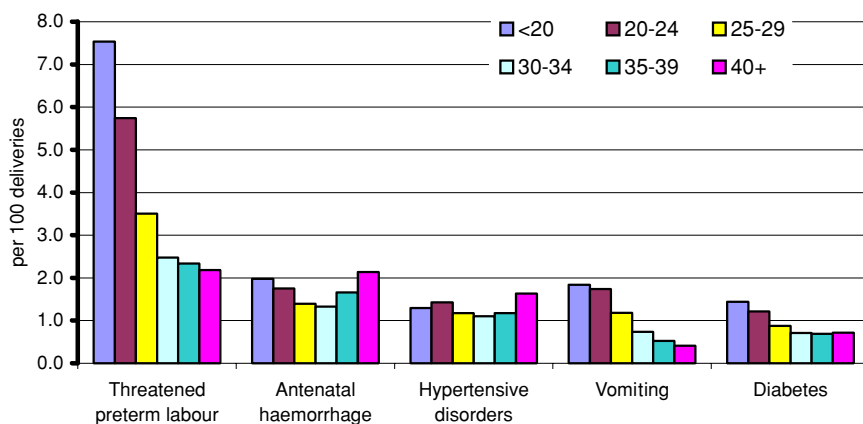
Threatened preterm labour accounted for almost a quarter of overall antenatal hospitalizations, and remained the leading cause (far higher than the second cause, antenatal hemorrhage: 10.1%) of admissions to hospital during pregnancy despite its dramatic decline from 1991 to 2003.

Hospitalization prior to delivery for a complication of pregnancy often represents a significant psychosocial burden for women of reproductive age and their families [18, 19]. In the past two decades, various alternatives to antenatal hospitalization have been developed in Canada, including antenatal home care programs, pregnancy day care programs, and increased use of outpatient services [20–24]. In addition, the advent of new technologies such as screening for fetal fibronectin and determining endocervical length by ultrasound may have prevented unnecessary hospitalizations for threatened preterm labour [25, 26]. Therefore, the decline in antenatal hospitalization in Canada likely reflects an increased access to other types of antenatal services and improved therapies, rather than barriers to access to

**Table 3** Antenatal hospitalization by primary diagnosis and length of in-hospital stay (mean  $\pm$  standard deviation [SD]), Canada excluding Quebec and Manitoba, 2001/02 and 2002/03

Primary diagnosis	Number	Proportion	Length of stay (mean $\pm$ SD)
1. Threatened preterm labour	17,372	23.6	2.1 $\pm$ 3.2
2. Antenatal hemorrhage	7,417	10.1	2.7 $\pm$ 3.8
3. Hypertensive disorders	5,914	8.1	2.5 $\pm$ 2.4
4. Vomiting	5,148	7.0	3.4 $\pm$ 3.5
5. Diabetes	4,288	5.8	2.4 $\pm$ 2.7
6. Genitourinary complications	3,944	5.4	2.4 $\pm$ 1.9
7. Rupture of membranes	2,820	3.8	2.8 $\pm$ 4.2
8. Abdominal pain	1,558	2.1	1.8 $\pm$ 1.6
9. Cervical incompetence	1,542	2.1	4.7 $\pm$ 7.4
10. Known and suspected fetal problems	1,379	1.9	2.5 $\pm$ 3.8
11. Intestine, liver and gallbladder disorders	1,220	1.7	2.5 $\pm$ 2.7
12. Mental disorder	929	1.3	6.7 $\pm$ 8.0
13. Other causes	19,949	25.6	2.5 $\pm$ 3.5
Total	73,480	100.0	2.6 $\pm$ 3.5

**Fig. 2** Antenatal hospitalization ratio per 100 deliveries for top five primary diagnoses by maternal age, 2001/02–2002/03



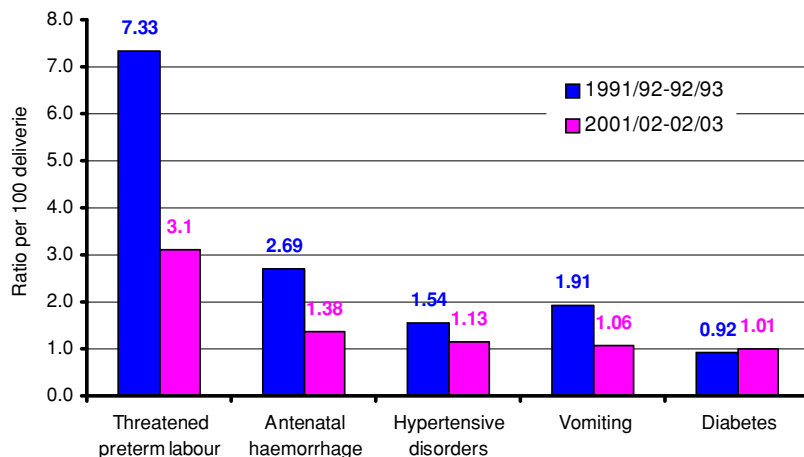
hospitalization services or an actual decrease in the incidence of pregnancy complications. The decline in antenatal hospitalization in Canada is also in line with a decline of overall hospitalization rates among the entire Canadian population [8, 9]. Correspondingly, we have previously reported a slight decline in postpartum rehospitalization since 1992/93 in Canada [15].

It is difficult to directly compare the ratio of antenatal hospitalization in Canada with those in other countries because of differences in the definitions of antenatal hospitalization and populations studied, as well as discrepancies in health care and hospital services. Nevertheless, the overall Canadian ratio of 15.1 non-delivery antenatal hospitalizations per 100 deliveries is generally consistent with reports from the United States [1–3] and Australia [11]. A report from Ukraine reported a much higher ratio of 47 antenatal admissions per 100 deliveries in 1991–1992, likely due to Ukrainian patterns of care that historically stressed hospital-based treatment [12]. The ideal antenatal hospitalization ratio is not known. The impact of declining ratios of antenatal hospitalization on maternal and infant morbidity and mortality should be studied in conjunction with trends in rates of maternal and infant morbidity and mortality. A decline

in antenatal hospitalization is appropriate only if it relates to improved or at least stable maternal and infant morbidity and mortality. In Canada, the rate of several severe maternal morbidities during delivery hospitalization increased from 1991 to 2000 [9], and the preterm birth rate has also been increasing,<sup>15</sup> so a re-evaluation of the optimal ratio of antenatal hospitalization may be warranted.

Generally, antenatal hospitalizations represent maternal morbidity resulting from maternal conditions during pregnancy. Higher antenatal hospitalization ratios in certain groups of women (e.g., adolescent) may be associated with a higher prevalence or more severe presentation of a condition [1–3]. For example, young pregnant women may have a relatively lower threshold to threatened preterm labour, and they are less likely to use prenatal care [3, 27]. Ratios of antenatal hospitalization among young women were higher than those among older women in our study, particularly for threatened preterm labour, suggesting that prevention of preterm labour for young women should be a major focus of prenatal care. On the other hand, higher ratios in some regions (e.g., the Yukon and Newfoundland) may be due to a lack of access to quality prenatal care in the rural or remote communities, or differential access or preference for receiving inpatient care

**Fig. 3** Antenatal hospitalization ratios per 100 deliveries for top five causes, 1991/92–1992/93 vs. 2001/02–2002/03, Canada



[5, 12]. Alternatively, lower antenatal hospitalization ratios in other regions may reflect easier access to prenatal care in those regions or better availability of home care or day care services for pregnant women.

Our data also indicate that several medical or obstetrical conditions (e.g., hypertensive disorders, diabetes and cervical incompetence) are strongly associated with the risk of antenatal hospitalization. While some of these antenatal hospitalizations are essential and even life-saving for the pregnant woman and/or her fetus, an unknown proportion is probably preventable, reflecting a failure to provide needed outpatient care during pregnancy [3]. Several studies have suggested that outpatient management of placenta previa (a cause of antenatal hemorrhage) [28–30], hypertension [21, 31] and premature rupture of membranes [20, 32] is as effective as inpatient management and could therefore provide an alternative to hospitalization. Other studies have demonstrated that antenatal home care and pregnancy day care programs are cost-effective and preferred by women compared with inpatient care [20–23, 33, 34]. In addition, prenatal education, routine maternal examination and screening, and patient monitoring for at-risk groups may be used to reduce the risk of maternal and fetal morbidity, and thereby the need for antenatal hospitalizations [35]. More research is warranted to examine whether and which antenatal hospitalizations can be safely reduced when pregnant women receive comprehensive and adequate outpatient care.

Certain limitations inherent in our study may have precluded us from providing a full picture of the incidence of hospitalization and maternal morbidity during pregnancy. First, our analysis was limited to non-delivery antenatal hospitalizations and did not include situations in which women remained in hospital until delivery; unfortunately, such an analysis is not possible with the DAD data. In a study by Adams et al., 15.7% of total antenatal admissions resulted in deliveries after 3 or more days of hospitalization [36]. Second, we could not differentiate multiple admissions or hospital transfers of the same woman because personal identifiable information is confidential and not disclosed [37]. Finally, we were unable to adjust the temporal trends or the changes by age group for factors such as pre-pregnancy weight, weight gain during pregnancy, smoking and parity because such data are not available in our database. Although we have demonstrated considerably higher antenatal hospitalization ratios in some provinces or territories, we cannot attribute the differences to inadequacy of outpatient prenatal care or poor quality ambulatory care, because many other factors might have played an important role. Nonetheless, our findings based on existing hospital discharge data are useful for quantifying the magnitude of the public health burden of pregnancy complications and associated hospital services, for drawing attention to the necessity of adequate prenatal care and for providing some direction for future

studies. The appropriateness of antenatal hospitalization for specific clinical scenarios and trends in maternal morbidity treated in settings outside of hospital is an important focus for future research [2, 3].

Our analysis has provided an additional view of maternal morbidity and reaffirmed that antenatal hospitalization is an important indicator of maternal morbidity. The observed decline in antenatal hospitalization ratios may reflect changes in management of pregnancy complications, e.g., transition from in-hospital care to out-of-hospital care, and introduction of antepartum home care and day care programs. Further study of antenatal hospitalization should obtain more detailed information on specific reasons for antenatal hospitalizations and associated factors to help identify preventable determinants.

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