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**Decreasing length of maternal hospital stay is not associated with increased readmission rates**

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## **Abstract**

**Objective:** To investigate changes in maternal length of postnatal stay by mode of birth and hospital type, and examine concurrent maternal readmission rates and reasons for readmission.

**Methods:** Linked birth and hospital separation data were used to investigate mothers' birth admissions (N=597,475) and readmissions (N=19,094) in the 6 weeks post-birth in New South Wales, Australia, 2001-2007. Outcomes were postnatal length of stay (mean days) and rate of readmission per 100 deliveries. Poisson regression was used to investigate annual readmission rates and Wilcoxon-Mann-Whitney test was used to compare length of readmission stays.

**Results:** The overall mean postnatal length of stay declined from 3.7 days in 2001 to 3.4 days in 2007. Private hospitals had longer stays after Caesarean and vaginal deliveries, but mean length of stay fell for both private and public hospitals, and both modes of birth. The maternal readmission rate fell from 3.4% in 2001 to 3.0% in 2007. Leading primary diagnoses at readmission following vaginal birth were postpartum haemorrhage and breast/ lactation complications and following Caesarean section were wound complications and breast/ lactation complications.

**Conclusions:** Despite the decrease in mean length of stay for birth admissions, there was no increase, and in fact a decrease, in the rate of postnatal readmissions.

**Implications:** Current practices in hospital length of stay and care for women giving birth do not appear to be having serious adverse health effects as measured by readmissions.

**Key words:** length of stay, patient readmission, data linkage, parturition, international classification of diseases

## **Introduction**

Length of hospital stay for childbirth has decreased around the developed world over the last decades(1-4). The main driver for reducing in-hospital stay is to reduce health care costs. International studies suggest that mean length of stay has decreased for both caesarean and vaginal deliveries, although such studies investigated overall length of stay rather than postnatal length of stay(4, 5). Analysis of overall length of stay may be skewed by lengthy antenatal admissions for pregnancy complications and therefore mask trends in postnatal stay.

Reported average length of maternal postnatal length of stay in Australia decreased from 5.1 days in 1991 to 3.7 days in 2000(6). The median length of stay reportedly dropped from 4.0 to 3.0 days between 2001 and 2007(7). New South Wales similarly reported decreased average postnatal stays from 3.5 days in 2001 to 3.4 days in 2005(8). These are still considerably longer than overall lengths of stay reported internationally: United States stay for births in 2008 was 2.6 days(9), in Canada stays in 2001 were 4.4 and 2.4 days for Caesarean and vaginal births(10), respectively.

It is unknown whether the reductions in Australian maternal postnatal length of stay have occurred across all birth modes and hospitals equally. Furthermore, patterns of postnatal length of stay and maternal readmission rates have not been concurrently explored. Maternal readmission is an important outcome indicator(11), as an event that would not usually be anticipated as part of routine care.

The aim of this study was to investigate if there have been changes in maternal length of postnatal stay by mode of birth and hospital type between 2001 and 2007. A secondary aim was to see if maternal readmission rates had changed over this period and investigate the primary reasons for readmission.

## **Methods**

The study population included all births in NSW hospitals to NSW residents, for the years 2001 to 2007 inclusive. The study used two linked NSW Health Department datasets: the Midwives Data Collection (MDC) which collects data on all births in NSW, and the Admitted Patient Data Collection (APDC) which is a dataset of all hospital discharge summaries in NSW. Use of these linked datasets has been described previously(12). MDC records which did not link to any hospital discharge summary (0.94%) were excluded from the analysis.

Each mother's hospital records were longitudinally linked so as to construct a "birth sequence" of hospital admissions. The birth sequence included the birth admission and any subsequent transfer admissions, up until a discharge home. Readmissions during the first six weeks after birth (the traditional definition for the postpartum period) were also identified and longitudinally linked. Transfers out-of-state could not be included; 0.07% of women were transferred outside of NSW after birth in 2001 and 0.06% were transferred in 2007.

Admission date, length of stay, and admission and discharge status were available in hospital data, as well as maternal age and hospital status. Socioeconomic quintile was assigned based upon maternal postcode, using the Australian Bureau of Statistics 2006 Socio-Economic Indexes for Areas index(13). Parity, multiple gestation, date of birth, onset of labour and mode of birth were determined from the Midwives Data Collection. Validation studies have shown that factors associated with hospital reimbursement (eg. length of stay) are likely to be well reported in administrative data(14). MDC reporting for variables used in this study has been shown to have excellent agreement with medical records (kappa >0.89) (15).

Outcomes were compared for births in private and public hospitals, and across modes of birth. Mode of birth was divided into two categories for the analysis: vaginal birth and Caesarean section. Failed inductions were included in the latter category.

Both mean (with standard deviation) and median length of postnatal stay (with interquartile range [IQR]) were tabulated for the birth sequence of admissions. Length of stay was calculated as the discharge date minus the date of birth; antenatal days were not included. For readmissions, total stay-days for all puerperal readmissions (for any reason including non-obstetric diagnoses) were tabulated for each woman. Dates of discharge could be after 42 days postpartum, providing that the admission date was on or before 42 days postpartum. Poisson regression was used to determine whether there was a statistically significant change in annual readmission rates. Rates of readmission are reported per 100 births and stratified by mode of delivery. Confidence intervals have not been reported given that this is whole population data, not a sample. The Wilcoxon-

Mann-Whitney test was used to compare the distribution of length of readmission stays for the years 2001 and 2007. Ethics approval for this study was granted by the NSW Population and Health Services Research Ethics Committee (2004-06-10).

## **Results**

There were 597,475 hospital births in the study. The number of births per year rose from 82,583 in 2001 to 91,886 in 2007 (a relative increase of 11.3%). Characteristics of the births at the beginning and end of the period are shown in Table 1. Maternal age increased over the period; the mean age in 2001 was 29.8 years in 2001 and 30.6 years in 2007. The percentage of vaginal births decreased from 76.3 to 70.7%. There was a decrease in births at smaller hospitals (<500 births per annum hospitals) from 11.5% to 8.5%, and an increase in births at tertiary referral hospitals from 25.9% to 28.0%.

The overall mean postnatal length of stay declined in every year, from 3.70 days in 2001 to 3.37 days in 2007. The annual means in total length of postnatal stay for birth sequence hospitalisations, by mode of birth and type of hospital (public/private), are plotted in Figure 1. Private hospitals had longer stays after both Caesarean and vaginal deliveries, but mean length of stay fell for both private and public hospitals, for both modes of birth. Post-Caesarean stays over the seven years fell slightly more in private (0.66 day decrease) than public (0.64 day decrease) hospitals. Post-vaginal birth stays fell slightly less in private hospitals (0.30 day decrease) than in public hospitals (0.36 day decrease).

Over the entire period 3.2% (N = 19, 094) of women were readmitted within six weeks of giving birth. Overall the readmission rate fell from 3.4% (N=2, 794) in 2001 to 3.0% (N= 2, 776) in 2007, a relative annual decline of 1.6% (95% CI 0.8, 2.2). The percentages of all women with a readmission, by mode of birth, are plotted in Figure 2. The rate of readmission after vaginal birth had a relative decline of 2.2% per annum (95% CI 3.1, 1.4). The rate of readmission after Caesarean section had a smaller relative decline of 1.3% per annum (95% CI 2.5, 0.1). Because of the rising rate of Caesarean section, the proportion of women with readmissions who were post-Caesarean rose from 30.2% (N=844) in 2001 to 38.8% (N=1, 078) in 2007.

Most women who were readmitted had total stays of one or two days or day only admissions, but 5% of readmissions lasted a week or more, resulting in a skewed distribution. Even after the exclusion of breast-related day only readmissions, 19.2% in 2001 were day only; in 2007, 19.8% were day only. The percentage of women who had multiple readmissions was only 0.3% but 89% of these multiple admissions involved at least one overnight stay. There was no statistically significant change from 2001 to 2007 in the median readmission total length of stay, for any of the modes of birth.

The distribution of principal diagnoses on first readmission (including day only admissions) is shown in Table 2. Over the period 2002-2004, yearly day only breast-related readmissions declined from 454 to 25, and remained below 30 per annum thereafter. Breast-related day only readmissions were therefore excluded from this table and from the remaining analyses. The “other” category of conditions includes less

frequent diseases and disorders such as gastroenteritis, appendicitis and respiratory tract infections, and also includes non-specific “not elsewhere classified” codes. Breast-related complications (including mastitis and breastfeeding difficulties) and postpartum haemorrhage were the most common principal diagnoses at readmission following vaginal birth, while obstetric wound complications and breast-related complications were the most common principal diagnoses following Caesarean section. The frequencies of presenting conditions were relatively stable over the study period, with the exception of breast-related day only readmissions.

## **Discussion**

Our study confirms that maternal length of postnatal stay decreased over the period 2001 to 2007 from an average of 3.7 to 3.4 days. This occurred in spite of a small rise in mean maternal age over the period, which might have been expected to lead to a rise in average length of stay, if anything. The decline appeared to occur uniformly across vaginal and Caesarean births and public and private hospitals. Mean length of stay was longer for Caesarean than vaginal births and for private compared to public hospitals. There is some evidence to suggest that length of postnatal stay after a vaginal birth showed a slower and slightly less marked decline for births in private compared to public hospitals.

Rates of maternal readmission also declined between 2001 and 2007 however the decline did not appear to occur at the same rates, with slower declines in readmission after Caesarean section than after vaginal birth (1.3% vs. 2.2% per annum decline).

Readmission rates in our study were higher than those reported in Canada where

provision of health care is very similar to Australia, and those reported in the United States (3.2% compared with 1.2%-1.8%)(16-18). However, these overseas studies were limited to low-risk women(16, 17) or were not based on whole population data(18). Consistent with other studies, we found higher readmission rates after Caesarean births compared with vaginal births(16, 17). The higher rates of readmission associated with Caesarean section reflect the morbidity risks associated with this procedure(19).

Despite the decrease in mean length of stay for birth admissions, there was no increase, and in fact a decrease, in the rate of postnatal readmissions. This is encouraging in the context of a rising proportion of births to women aged 35 years or older, tertiary hospital births and caesareans all of which confer (advanced maternal age, caesareans) or are indicative of (tertiary hospital births) additional risk of adverse outcomes at birth and beyond. In addition, it appears that the growth in numbers of births and the associated pressure this has placed on hospitals has not translated into a rise in readmissions.

It is unclear whether the observed variation in yearly readmission rates, particularly the apparent increase in readmissions in 2006 following a decreasing trend, are random fluctuations or not. There are a number of potential factors that could have affected readmission rates but which we cannot evaluate in the available population data. After the 2002 publication of a systematic review identifying benefit from prophylactic antibiotics in reducing post-Caesarean section wound infection there is likely to have been a change in practice in prophylactic antibiotic administration(20). It has also been suggested that there has been an increase in the use of low molecular weight heparin for

thromboprophylaxis during the study period(21). Other potential changes in management which could have affected readmission rates include the increased use of syntocinon for induction of labour(22) which may affect breastfeeding establishment, changes in the management of third stage of labour and postpartum haemorrhage(23), and increasing recognition and possible treatment of women with postnatal depression.

To the authors' knowledge this is the first time rates and reasons for readmission during the postpartum period following birth have been investigated in Australia. While there is no international consistency in categorisation of principal diagnoses at readmission nor length of time in followup post-birth, the leading reasons for readmission presented here (breast complications, postpartum haemorrhage and wound infection) are consistent with findings from other studies. Liu et al found principal diagnoses at readmission to include postpartum haemorrhage and puerperal infection after vaginal birth, and wound or other puerperal complications and puerperal infection after Caesarean birth(17). Lydon-Rochelle et al found a higher incidence of rehospitalisation for uterine infection, postpartum haemorrhage and gallbladder disease than for other specific diagnoses after vaginal birth and for obstetrical surgical wounds, thromboembolic and cardiopulmonary diagnoses after caesarean birth(16).

Breast complications feature as a primary reason for readmission in some studies (16, 18) but not others (17). Our study revealed a potential change in management of breast complications postpartum with a marked decline in day-only admissions from 2002 onwards. Variable availability of postpartum lactation support and midwifery support is likely to affect the proportion of admissions for breast complications. The consistent

finding that a high proportion of readmissions are associated with postpartum haemorrhage is notable. The magnitude of post-hospitalisation haemorrhage is likely under-estimated due to primary care or outpatient management of many cases. Only the more severe cases of haemorrhage requiring evacuation of retained products or transfusion are likely to be captured in rehospitalisation data. Wound infections remain a leading factor in postpartum readmission (16-18). Although beyond the scope of this study, it remains to be seen if thromboprophylaxis or changes in wound management may be affecting trends in wound infections over time.

The consistent inclusion of gallbladder or cholelithiasis diagnoses in leading diagnoses associated with readmission is perhaps surprising. Another study identified a high rate of readmission with gallbladder disease (10.8 per 10,000 deliveries), concluding that there are a few possible explanations: a truly increased rate, or nonspecific postoperative pain may be falsely attributed to cholecystitis or appendicitis, or it may be related to increased opportunity for diagnosis given increased access to health care during the postpartum period(18). Whether related to physiological changes during pregnancy, population changes such as increased maternal age or obesity, or increased opportunities for diagnosis it is important for clinicians and women to be aware of the potential for biliary tract problems during the postpartum period.

Maternal lengths of postpartum stay reported in this study are longer than those described elsewhere around the world. Lengths of stay and readmission rates at the time of birth are likely to be related to local policy and practice in: antenatal admission, postpartum follow-up available (for both mothers and newborns), access to primary

care, availability of private care, as well as characteristics and expectations of the obstetric population. Unlike in the United States(24, 25), no population-based research has been conducted in Australia investigating the relationship between maternal length of stay and adverse maternal and neonatal outcomes.

Strengths of this study include the use of population data on all births and readmissions within the postpartum period, the ability to identify postnatal length of stay rather than overall length of stay, and the concurrent description of population trends in postnatal length of stay and readmission rates.

Limitations of the study include reliance upon hospitalisation data which may under-enumerate pregnancy-related diagnoses in the postpartum period, inability to track changes in practice including administration of antibiotics or thromboprophylaxis and being unable to capture postpartum complications that do not result in hospital admission. Furthermore, it has been estimated that one-third of New South Wales women leave hospital under early discharge programmes(26). Given the absence of information on which women were discharged under early discharge programmes (involving further follow-up care at home) and which women were discharged without ongoing care, and of any medications dispensed, it was not deemed useful to attempt to model readmission as a function of birth length of stay. The authors reasoned that adverse effects of reduced length of stay (measured via a readmission proxy) would therefore be best reported as unadjusted whole population rates in the first instance.

In summary, at a population level it does not appear that reductions in postnatal length of stay are associated with increasing rates of readmission. In fact, readmission rates are decreasing. This is despite changing population trends in characteristics of women giving birth including advanced maternal age, rising obesity and birth by caesarean, as well as the increased number of births, factors which may increase the likelihood for readmission.

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**Table 1. Maternal demographic and delivery characteristics at birth admission, 2001 and 2007**

Maternal/delivery characteristic	2001	2007
	N=82,583	N=91,886
	(%)	(%)
Maternal age <20 years	4.5	3.5
Maternal age 20-34 years	77.4	73.6
Maternal age $\geq$ 35 years	18.1	22.9
Nulliparous	41.7	41.6
Multiple gestation	1.7	1.5
Lowest area socioeconomic quintile	19.9	19.7
Delivery in private hospital	24.9	24.7
Delivery at tertiary referral hospital	25.9	28.0
Delivery hospital <500 births p.a.	11.5	8.5
Vaginal delivery	76.3	70.7
Caesarean section	23.7	29.3

**Figure 1. Mean length of postnatal stay by year, mode of delivery and public/private hospital.**

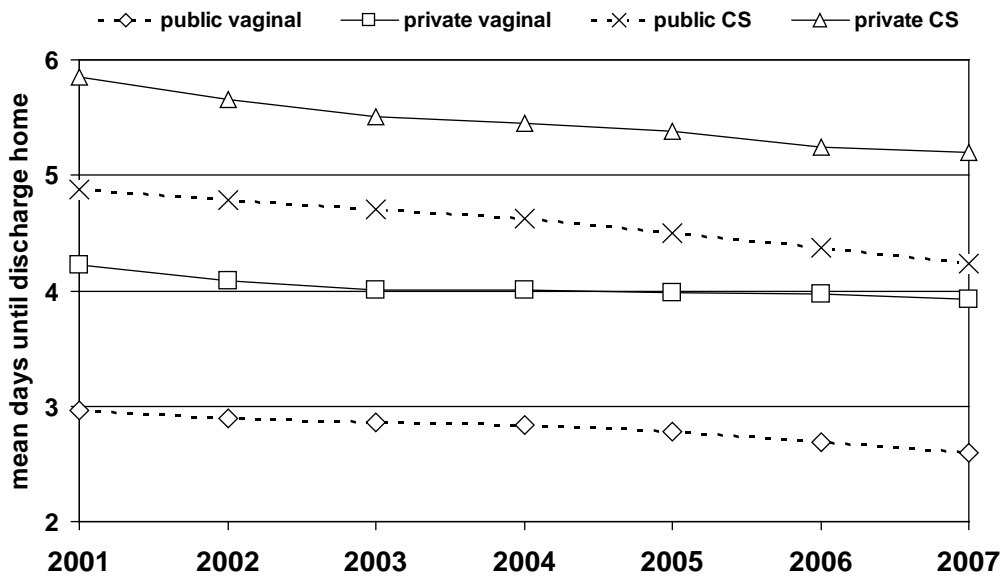
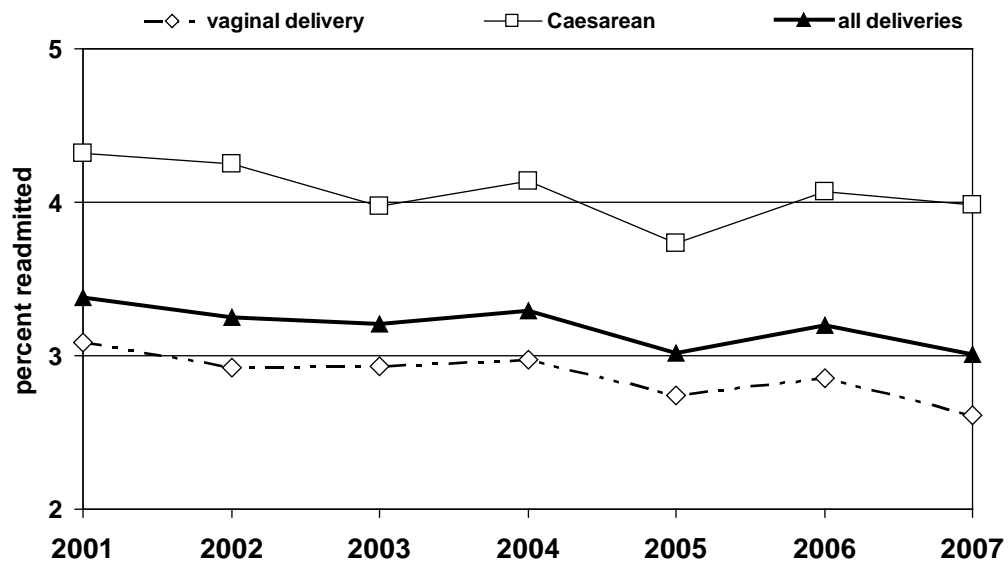


Figure 2. Percent readmitted out of all births, by mode of delivery



**Table 2. Frequency of first-listed ICD10 conditions on first postpartum readmission, 2001-2007**

Admission related to	after vaginal delivery (%)	after Caesarean (%)
Postpartum haemorrhage	18.3	7.4
Breast or lactation complications (>1 day)	15.2	10.3
Obstetric wound infection/complication	1.8	19.2
Endometritis/puerperal sepsis	7.4	5.4
Maternal care/observation	4.5	5.7
Mental health disorders	5.2	4.5
Retained placenta/ products of conception	4.1	1.3
Cholelithiasis	2.9	2.4
Abdominal pain	2.2	2.9
Urinary tract infection	1.6	1.6
DVT or pulmonary embolism	1.1	2.1
Other	33.6	35.8
No condition recorded	2.2	1.6