



available at www.sciencedirect.com



journal homepage: www.elsevier.com/locate/wombi



Birth outcomes associated with interventions in labour amongst low risk women: A population-based study

Sally K. Tracy^{a,*}, Elizabeth Sullivan^a, Yueping Alex Wang^a, Deborah Black^b, Mark Tracy^{c,d}

^a Australian Institute of Health and Welfare, National Perinatal Statistics Unit, School of Women's and Children's Health, Faculty of Medicine, University of New South Wales, Sydney, NSW 2031, Australia

^b School of Public health, Faculty of Medicine, University of New South Wales, Australia

^c Neonatal Intensive Care Unit, Nepean Hospital, Sydney Western Area Health Service, Sydney, Australia

^d Department of Paediatrics and Child Health, Faculty of Medicine, University of Sydney, Sydney, Australia

Received 15 December 2006; received in revised form 21 March 2007; accepted 22 March 2007

KEYWORDS

Labour interventions;
Epidurals;
Unassisted vaginal birth;
Population-based study;
Instrumental birth

Summary

Introduction: Despite concern over high rates of operative birth in many countries, particularly amongst low risk healthy women, the obstetric antecedents of operative birth are poorly described. We aimed to determine the association between interventions introduced during labour with interventions in the birth process amongst women of low medical risk.

Methods: We undertook a population-based descriptive study of all low risk women amongst the 753,895 women who gave birth in Australia during 2000–2002. Adjusted odds ratios (AOR) were calculated using multinomial logistic regression to describe the association between mode of birth and each of four labour intervention subgroups separately for primiparous and multiparous women.

Results: We observed increased rates of operative birth in association with each of the interventions offered during the labour process. For first time mothers the association was particularly strong.

Conclusions: This study underlines the need for better clinical evidence of the effects of epidurals and pharmacological agents introduced in labour. At a population level it demonstrates the magnitude of the fall in rates of unassisted vaginal birth in association with a cascade of interventions in labour and interventions at birth particularly amongst women with no identified risk markers and having their first baby. This information may be useful for women wanting to explore other methods of influencing the course of labour and the management of pain in labour, especially in their endeavour to achieve a normal vaginal birth.

© 2007 Published by Elsevier Australia (a division of Reed International Books Australia Pty Ltd) on behalf of Australian College of Midwives.

* Corresponding author. Tel.: +61 420277106; fax: +61 2 93821025.
E-mail address: stracy@ozemail.com.au (S.K. Tracy).

Introduction

Many aspects of intrapartum maternity care have been evaluated by randomised clinical trials, providing midwives obstetricians and women a wealth of evidence to guide practice decisions.^{1,2} However, the use of interventions to modify the physiological processes of labour and birth^{3–6} combined with the rising rates of litigation in obstetrics^{6–8} continues to promote debate.^{9–11} Rates of spontaneous unassisted birth and rates of labour induction and cesarean section vary both within and between European countries,¹² the UK,¹³ the US¹⁴ and Australia.¹⁵

Normal physiological birth still remains a desired outcome for many of the world's women despite a perceived 'anti-vaginal' birth movement.^{16–18} In 2004 a consumer survey lamented the perceived lack of progress in changing conventional maternity systems over the past decade.¹⁹ In 2005 in the US a national consumer forum held in Philadelphia, PA, heard that 'women are more passive, and childbirth is increasingly a planned medical event with an over utilization of technology, with increasing C/section rates and no time or capacity for patient education'.²⁰

Despite concern over the high rate of operative birth in many resource rich nations particularly amongst low risk healthy women, the obstetric antecedents of operative birth are poorly described and as yet there is no clear consensus in the literature whether or not the rates of cesarean section are associated with unintended side effects of the use of epidurals.^{21–24}

Although a population-based cohort study cannot determine causative relationships, it can observe associations that occur between interventions in labour and subsequent birth outcomes. Our aim was to determine the association between interventions introduced in labour with the interventions in the birth process amongst women of low medical risk and to ascertain the current status of unassisted spontaneous vaginal birth in relation to obstetric interventions experienced during labour amongst these low risk women.

Methods

Data on all women who gave birth in Australia from the 1 January 2000 to 31 December 2002 were obtained from the National Perinatal Data Collection. This collection comprises cross-sectional data on all births in Australia and is maintained and validated²⁵ by the Australian Institute of Health and Welfare. Information on each birth is collected by midwives and contributed to the population-based surveillance systems covering all births in each state and territory of Australia. Data collected includes maternal demographic factors, pregnancy and labour characteristics and neonatal outcomes.

The study population consisted of all women who gave birth in Australia over the 3 years and who satisfied the following low risk criteria. (These criteria attempt to standardise the sample of women for comparative purposes by ruling out any identifiable risk factors reported in the database that might lead to a need for intervention or an operative birth.) Women were aged between 20 and 34 years; they had no previous medical history of hypertension or diabetes and no obstetric history of gestational hypertension or gesta-

tional diabetes. They gave birth to a live singleton cephalic-presenting infant of normal size (10th to 90th birth weight percentile)²⁶ born at term (greater than or equal to 37 completed weeks and equal to 41 completed weeks gestation).

We examined data for primiparae (first birth) and multiparae (previous births) separately, and adjusted for maternal age, maternal Indigenous (Aboriginal and Torres Strait Island People) status, private patient accommodation status, and gestational age of the infant as a continuous variable 37–41 weeks.

In Australia, women who elect private accommodation status are treated as private patients under private obstetric care at the place they give birth. This could either be in a private or public hospital. Women in Australia, like their counterparts in the US and to a lesser extent in the UK and New Zealand have the option of private obstetric care during pregnancy and childbirth.

The category of labour is recorded as 'spontaneous onset', 'induced', or 'no labour'. Labour interventions included: analgesia/anaesthesia (epidural, caudal or spinal) for pain management; induction or augmentation of labour with pharmacological agents such as oxytocin, prostaglandins or a combination of surgical and pharmacological methods and artificial rupture of membranes (ARM); but not artificial rupture of membranes alone.

In defining the labour interventions associated with operative birth, we specified four subgroups of interventions based on their chronological introduction to the labour process before a woman gives birth. These were:

1. no intervention in labour (no induction/no epidural);
2. induction of labour without an epidural (no epidural/induction);
3. epidural without an induction or augmentation of labour (epidural/no induction);
4. epidural with either induction or augmentation of labour (epidural and induction).

Induction and augmentation are grouped together in the third and fourth category because the sequence of adding an epidural and induction or augmentation in the labour process is not known. From a labouring woman's point of view the intervention involves a similar process of having a 'drip to speed up the labour process'. We also note that where an attempt at vaginal birth is indicated the practice of electively adding oxytocin infusions appears to have become 'routine' once an epidural is in situ.^{21,23,27}

Mode of birth was recorded as: unassisted vaginal birth, instrumental birth (which included both vacuum extraction and forceps); or cesarean section with labour (we excluded cesarean section where there was no record of the onset of labour.)

Analysis

Adjusted odds ratios (AOR) were calculated using multinomial logistic regression to describe the association between each of the four interventions in labour and the odds of either an instrumental (forceps or vacuum) birth or a cesarean section with labour. The referent outcome was either instrumental

birth or cesarean section with no prespecified labour intervention. Adjustments were made for maternal age (in three defined groups 20–24; 25–29; 30–34), private health accommodation status, maternal Indigenous (Aboriginal and Torres Strait Island People) status and gestational age of the infant (37–41 weeks) as a continuous variable.

The results were graphed to illustrate the associations between interventions and mode of birth and the frequency of unassisted vaginal birth. All data were analysed with Statistical Package for Social Sciences.²⁸

Results

There were 753,895 women who gave birth to 766,659 babies in Australia between 1 January 2000 and 31 December 2002. In the total population from which the low risk cohort was drawn, the ratio of public to private patient accommodation status has remained relatively unchanged over the past 10

years with the ratio between public and private 60:40 for primiparae and 70:30 for multiparae. Less than 2% of primiparous women and less than 4% of multiparae identified themselves as Indigenous Australians. One-tenth of women having a first baby during 2000–2002 were aged over 35 years. Based on our definition of 'low risk', 363,794 women satisfied the low risk criteria and were included in the study. Of these women 145,211 (39.92%) were primiparous and 218,583 (60.08%) multiparous women.

Table 1 shows the frequency of selected labour and birth outcomes for low risk women. It shows that amongst a cohort of healthy low risk women in Australia the levels of intervention in labour were high particularly amongst first time mothers. Of those women (26.51%) had their labour induced and amongst those who had a spontaneous onset of labour (44.32%) had their labour pharmacologically augmented (Table 1). The rate of epidural/caudal or spinal analgesia/anaesthesia was significantly higher amongst low risk first

Table 1 Selected maternal, labour and birth factors for low risk women by parity 2000–2002, Australia

	No. (%)	
	Primiparae (n = 145,211)	Multiparae (n = 218,583)
Maternal age		
20–24	37,686 (26.0)	34,940 (16.0)
25–29	60,159 (41.4)	80,990 (37.0)
30–34	47,366 (32.6)	102,653 (47.0)
Patient classification		
Public patients	89,309 (61.5)	153,450 (70.2)
Private patients	51,869 (35.7)	60,653 (27.7)
Other/not stated	4,033 (2.7)	4,480 (2.0)
Indigenous status		
Australian non-indigenous	140,150 (96.5)	204,586 (93.6)
Australian indigenous	1,650 (1.1)	8,389 (3.8)
Not stated	3,411 (2.3)	5,608 (2.5)
Onset of labour		
Spontaneous	100,528 (69.2)	142,187 (65.0)
Induced	38,502 (26.5)	47,563 (21.7)
No labour	6,141 (4.2)	28,721 (13.1)
Augmentation^a		
None	55,954 (55.6)	102,087 (71.8)
Yes	44,554 (44.3)	40,037 (28.1)
Analgesia/anaesthesia		
None	16,820 (11.5)	59,979 (27.4)
Epi/Caud/Spi ^b	67,489 (46.4)	58,656 (26.8)
Other	60,828 (41.8)	99,868 (45.7)
Missing	74 (0.0)	80 (0.0)
Mode of birth		
Unassisted vaginal	82,467 (56.8)	171,866 (78.6)
Forceps	14,933 (10.2)	2,959 (1.3)
Vacuum	19,159 (13.2)	5,735 (2.6)
C/section without labour	6,015 (4.1)	28,605 (13.0)
C/section with labour	22,603 (15.5)	9,324 (4.2)
Other	24 (0.0)	79 (0.0)

Note: Sum of percentage in column not always equal to 100 because not all categories were presented. C/section refers to cesarean section.

^a Augmentation was recoded only for women with spontaneous onset of labour.

^b Epi/Caud/Spi refers to the introduction of agents via epidural, caudal or spinal route.

time mothers (46.48%) than low risk women having a second or subsequent baby (26.83%) (Table 1). The variation in the prevalence of operative birth (instrumental and caesarean) between low risk first time mothers and women having their second or subsequent baby was (43.18%) versus (21.33%); and the rate of unassisted vaginal birth was more than 20 percentage points lower for primiparous women (56.79%) versus (78.63%).

Table 2 illustrates the odds and adjusted odds of each operative birth outcome (instrumental or caesarean section) in association with the addition of interventions in the labour process. The referent outcome is either an instrumental birth or caesarean section in association with no interventions used in labour. After testing for a relationship using univariate analysis the adjusted model we used controlled for maternal age, maternal Indigenous status, private patient accommodation status, and gestational age and these results are presented in Table 2. The left hand column shows the number of women in each labour intervention subgroup as a number and a percentage of the entire sample of low risk primiparous or multiparous women.

Primiparous low risk women

Approximately one-third (32.95%) of all primiparous low risk women were likely to have an induction or augmentation of

their labour combined with an epidural. Amongst these women the most frequent outcome was an operative birth, either a forceps or vacuum instrumental birth (36.76%), or caesarean section (33.51%). Less than one-third of the women with induction or augmentation and epidural (29.65%) achieved an unassisted vaginal birth (Table 2).

The adjusted odds ratios in Table 2 represent the likelihood of having either a caesarean section with labour or an instrumental birth following interventions introduced during labour. Low risk primiparous women were twice as likely (AOR 2.04; 99% CI 1.79–2.32) to have a caesarean section and one and a half times more likely (AOR 1.55; 99% CI 1.47–1.64) to have an instrumental birth following induction or augmentation during labour. When an epidural was combined with induction or augmentation the adjusted odds of an operative birth were 8.07 times greater (AOR 8.07; 99% CI 7.67–8.50) for instrumental birth; and 52.18 times greater (AOR 52.18; 99% CI 46.92–58.04) for caesarean section after the onset of labour (Table 2). The frequency of spontaneous unassisted vaginal birth is shown in Fig. 1 as a diminishing proportion of the birth outcomes in each intervention subgroup (Fig. 1). The concomitant increase in rates of operative or instrumental birth with the falling rate of unassisted vaginal birth is illustrated in Fig. 2 in association with the introduction of labour interventions (Fig. 2).

Table 2 Labour intervention by mode of birth amongst low risk primiparous and multiparous women Australia, 2000–2002

	Unassisted vaginal %	Forceps or vacuum			C/section with labour		
		%	OR (99% CI)	AOR ^a (99% CI)	%	OR (99% CI)	AOR ^a (99% CI)
Primiparous women (n = 145,211)							
No epidural, no induction ^b [n = 41,899 (28.8%)]	86.3	11.8	1.00	1.00	1.7	1.00	1.00
No epidural, induction ^b [n = 34,941 (24.0%)]	78.6	17.9	1.66 (1.57–1.75) ^c	1.55 (1.47–1.64) ^c	3.4	2.24 (1.98–2.53) ^c	2.04 (1.79–2.32) ^c
Epidural, no induction ^b [n = 14,025 (9.6%)]	31.8	36.9	8.42 (7.89–8.99) ^c	7.88 (7.37–8.44) ^c	31.0	49.43 (44.20–55.27) ^c	48.15 (42.87–54.09) ^c
Epidural, induction ^b [n = 47,851 (32.9%)]	29.6	36.7	9.01 (8.58–9.46) ^c	8.07 (7.67–8.5) ^c	33.51	57.35 (51.80–63.50) ^c	52.18 (46.92–58.04) ^c
No labour [n = 6141 (4.2%)]							
Missing data [n = 354 (0.2%)]							
Multiparous women (n = 218,583)							
No epidural, no induction ^b [n = 91,181 (41.7%)]	97.3	1.7	1.00	1.00	0.9	1.00	1.00
No epidural, induction ^b [n = 65,394 (29.9%)]	96.2	2.7	1.60 (1.46–1.75) ^c	1.46 (1.33–1.61) ^c	0.9	1.05 (0.91–1.20)	1.11 (0.96–1.28)
Epidural, no induction ^b [n = 10,867 (4.9%)]	48.1	13.8	16.03 (14.51–17.71) ^c	14.39 (12.97–15.97) ^c	36.8	82.25 (74.05–91.36) ^c	93.67 (84.05–104.52) ^c
Epidural, induction ^b [n = 21,911 (10.0%)]	66.6	17.2	14.47 (13.36–15.69) ^c	12.32 (11.31–13.42) ^c	16.0	25.91 (23.39–28.70) ^c	30.63 (27.50–34.11) ^c
No labour [n = 28,721 (13.1%)]							
Missing data [n = 509 (0.2%)]							

Note: Sum of percentage in row of each variable was not always equal to 100 because not all categories were presented.

^a AOR was adjusted for maternal age (20–24; 25–29; 30–34); patient accommodation (private or public) classification; maternal Indigenous (Aboriginal and Torres Strait Island) status and gestational age of infant (37–41 weeks).

^b Induction includes both induction and augmentation of labour with oxytocin, prostaglandins, ARM and combined types, but not Artificial Rupture of Membranes (ARM) alone.

^c $p < 0.01$.

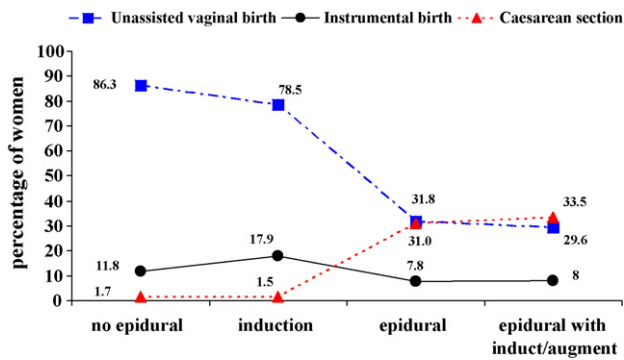


Figure 1 Rate of unassisted vaginal birth in association with instrumental and caesarean births amongst ‘low risk’ first time mothers, Australia, 2000–2002.

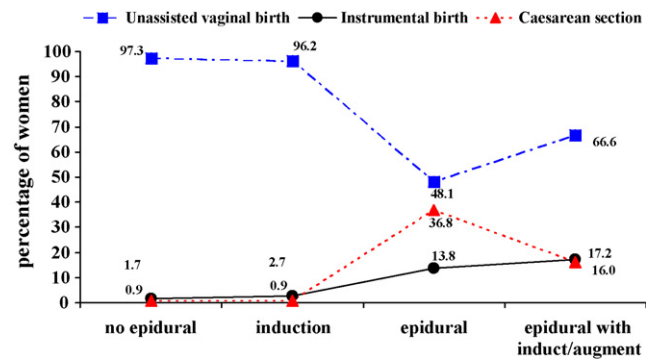


Figure 3 Rate of unassisted vaginal birth in association with instrumental and caesarean births amongst ‘low risk’ multiparous women, Australia, 2000–2002.

Low risk multiparous women

Amongst low risk multiparous women (29.92%) had an induction of labour (without an epidural). This increased the adjusted odds by 1.46 times (AOR 1.46; 99% CI 1.33–1.61) of having an instrumental birth, either forceps or vacuum extraction, but did not increase the odds in a statistically significant way for caesarean section with labour (Table 2). Amongst the (10.02%) of multiparous low risk women who had induction or augmentation in labour combined with an epidural the adjusted odds of an instrumental birth were 12.32 times greater (AOR 12.32; 99% CI 11.31–13.42); and the adjusted odds of a caesarean section with labour were 30.63 times greater (AOR 30.63; 99% CI 27.50–34.11) than the odds of these events when no interventions were offered in labour (Table 2). Amongst low risk multiparous women the frequency of spontaneous unassisted vaginal birth is shown in

Fig. 3 as a proportion of the birth outcomes in each intervention subgroup (Fig. 3). The rates of spontaneous unassisted birth and caesarean section appear to be modified slightly by the introduction of pharmacological agents through induction or augmentation (Fig. 3).

The concomitant increase in rates of operative or instrumental birth with the falling rate of unassisted vaginal birth is illustrated in Fig. 2 in association with the introduction of labour interventions (Fig. 2).

Discussion

This study demonstrates the decreased rate of unassisted vaginal birth in association with interventions that were used during the labour process amongst women without major medical risk markers identified. For low risk primiparous women the rate fell from 86.3 to 29.6% of births as interven-

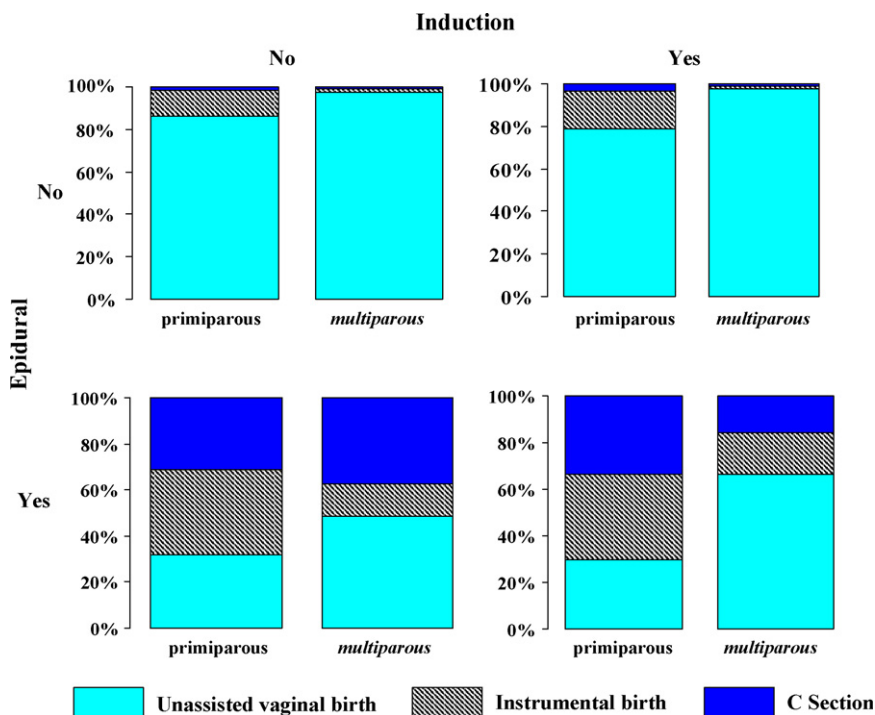


Figure 2 The association between interventions in labour with birth outcome amongst low risk women, Australia, 2000–2002.

tions were introduced in labour. This raises several important issues for clinicians and for women. It raises the question whether first time mothers should be particularly concerned about the high frequency of instrumental or cesarean birth they are exposed to when they are induced or augmented and have an epidural for pain relief? In addition it reinforces the need for further evidence to explain the causal pathways if they do exist between obstetric antecedents such as induction or augmentation and the use of epidural pain relief during labour and the fall in the rate of unassisted vaginal birth. For practitioners in midwifery and obstetrics it raises questions about the nature of maternity care for low risk healthy women which currently often includes the routine use of induction for the onset of labour and epidural pain relief. The epidemiological use of entire population data sets is vital to describe patterns of associations together with the strength of association. A cross-sectional study such as this provides baseline data to inform other more inductive research such as randomised controlled trials.

The limitations of our study include not being able to identify congenital anomalies, although the study population included only live births. We are also limited as are similar studies undertaken with large population data sets, in our inability to demonstrate cause and effect, and the lack of additional specific clinical information concerning the need to intervene. In terms of cesarean section it is not possible to distinguish whether epidural results in an operative birth or is used to facilitate operative birth. It is possible to speculate however, that women in these low risk categories who have an induction or augmentation of their labour in addition to an epidural are most likely doing so in the first instance to expedite vaginal birth. The surprising result is the high percentage of these women at minimal medical risk who progress to cesarean section after the onset of labour; a third (33.51%) of primiparous women and 16.05% of multiparous women.

The strength of our study lies in the large national sample size to detect differences in the outcomes of interest. Although the definition of 'low risk' is a 'crude' measure dependent on the availability of data to match the criteria, the strength of identifying a low risk population cohort that can be compared internationally has merit,^{13,29,30} and it avoids the use of complex statistical methods to control for potentially modifying factors of parity, maternal age and medical or obstetric risk.

Epidurals and cesarean section

There have been attempts to disentangle the unintended side effects of epidurals for pain relief. The Comparative Obstetric Mobile Epidural Trial (COMET) trial³¹ in the UK concluded that one in four operative births might be avoided through the use of low dose or combined spinal analgesia/anaesthesia for primiparous women in labour.³¹ More recently, Lieberman et al.³² published a prospective cohort study of 1562 women demonstrating changes in fetal position during labour and their association with epidural analgesia. The researchers observed changes in fetal position during labour using serial ultrasound examinations and found a strong association between the use of epidural in labour with fetal occiput posterior position at birth (AOR 4.0; 95% confidence interval 1.4–11.1).³²

The Cochrane systematic review of epidurals compared to other analgesia for labour found no evidence of a statistically

significant difference in the risk of cesarean delivery (RR 1.07, 95% CI 0.93–1.23, 20 trials, 6534 women).²¹ However, it may be that either the trial numbers were too small or the high rate of crossover within the trials²¹ diminished the power of the review to answer the clinically significant question regarding unwanted side effects of epidurals. In addition to this, some have questioned both the internal and external validity of the trials included because of the heterogeneity in terms of for example labour management or the inclusion of both primiparous and multiparous women in the analysis without stratifying for parity.²²

A large population-based cohort of 12,944 singleton, live-born, term pregnancies, the Avon Longitudinal Study of Parents and Children (ALSPAC) study,³³ found that epidural use was associated with an increased risk of emergency cesarean (OR 6.49; 95% CI 4.78–8.82) while being in a preferred labour position decreased the risk (OR 0.59; 95% CI 0.49–0.73). Similarly, one small prospective randomised control trial published over 12 years ago and 'uncontaminated' by high rates of crossover from the experimental to control group and vice versa,³⁴ found the relative risk amongst primiparous women of having a cesarean section following an epidural during labour was 11.4 times greater (95% CI 5.8–16.9). That trial was stopped on the grounds that it was unethical to continue to randomise because of the statistically significantly increased rates of cesarean section amongst those with epidural pain relief.³⁴

In Sweden, researchers used the Swedish birth registry,³⁵ to examine the association between the frequencies of epidural block at *institutional level* (instead of an individual level), and mode of delivery, thus avoiding the risk of selection bias and found no relationship between a unit's epidural rate and its rates of CS or instrumental delivery. One criticism of the Swedish study was the use of institutions with a 40–49% epidural usage as the referent group.³⁵ This suggests that having an epidural is a normal procedure for labour and birth, whereas the referent group in our study consisted of women who had no epidural or induction during labour.

Our study findings are important because the rate of primary cesarean section has implications for women for future pregnancies.³⁶ Increasingly women are being advised to give birth by cesarean section in their second and subsequent births following a first cesarean.³⁷ In Australia in 2003, of the women who had a history of previous cesarean section, 81.4% were likely to have another cesarean section whilst 14.9% had a spontaneous vaginal birth, and 3.5% had an assisted vaginal delivery.¹⁵

Instrumental birth and epidurals

The finding of an increased rate of instrumental birth for both low risk primiparous (8.07 times greater) and multiparous women (12.32 times greater), in association with an epidural combined with induction or augmentation is also a cause for concern. This is a stronger association than the Cochrane systematic review of 17 trials and 6162 women (relative risk (RR) 1.38; 95% CI 1.24–1.53).²¹ The implications for women following an instrumental birth are well known.³⁸ A recently published longitudinal study found that a first birth by forceps delivery incurred about a two-fold increase in the risk of having persistent faecal incontinence, and that in about half these cases faecal incontinence persisted for at least 5

years.³⁹ Attempts to modify the effects of epidurals on instrumental birth have also been unsuccessful. The Cochrane review of discontinuing epidurals in the second stage of labour concluded that there is no evidence that this has any significant impact on the rate of instrumental birth. The practice merely resulted in a three-fold increase in inadequate pain relief when the epidural was stopped (22% versus 6%, RR 3.68, 95% CI 1.99–6.80).⁴⁰

What evidence do we have?

Given the widespread use of epidural block during labour, there remain relatively few data from randomised trials concerning the short-term and long-term effects on women and their babies. In particular, long-term follow-up of infants in relation to feeding and mother–infant interactions is very scarce.^{21,23,41} Published reviews have found that an epidural block is likely to provide more effective pain relief during labour than alternative pharmacological methods²¹; it does not increase the incidence of long-term backache⁴²; it is associated with an increased rate of induction or augmentation of labour,²³ and the use of antibiotics for maternal fever.⁴³ Studies have also shown that epidurals may alter the dynamics of labour^{21,32,44} maternal temperature regulation^{21,23} and result in increased rates and costs of operative birth.^{21,23,41,45–47} They are associated with important other maternal complications that require further intervention such as intravenous fluids to attenuate the decrease in maternal blood pressure^{23,48} and catheterization to avert urinary retention^{21,23}; and continuous electronic fetal heart rate monitoring throughout the duration of labour.^{23,27,41,49}

Conclusion

In 1976 Chalmers et al. established the need for rigorous experimental data to determine the true place of induction, and of other medical innovations in the management and outcome of pregnancy.⁵⁰ Thirty years on we cannot say to what extent the global increase in epidural usage and induction of labour amongst all women, particularly low risk healthy women, is implicated in potentially avoidable instrumental and surgical birth outcomes. This study underlines the need for better clinical evidence of the effects of epidurals and pharmacological agents introduced in labour. At a population level it demonstrates the magnitude of the fall in rates of spontaneous vaginal birth in association with a cascade of interventions in labour and interventions at birth particularly amongst women with no identified risk markers and having their first baby. Because childbirth is a highly complex and individual process and not all women want or need induction of labour or analgesia during labour, this information may provide a useful ‘tool’ for women wanting to explore other methods of influencing the course of labour and the management of pain in labour, especially in their endeavour to achieve a normal vaginal birth.

Competing interests

None declared.

Acknowledgments

Contributors: SKT, MBT and ES initiated the research, participated in study design and data analysis and interpretation of the data. SKT wrote the paper and will act as guarantor for the paper. MBT participated in the study design, writing the paper and analyzing and interpreting the data. YAW applied statistical methods and data analysis. DB supervised statistical analysis and interpreted the data.

Funding: SKT is fully funded by a National Health and Medical Research Foundation Capacity Building Grant awarded to the Health Evaluation Research and Outcomes Network (HERON): Using population health data to improve health services, policy and planning.

References

- Hofmeyr GJ. Evidence-based intrapartum care. *Best Pract Res Clin Obstet Gynaecol* 2005;**19**(1):103–15.
- Enkin M, Keirse MJNC, Renfrew MJ, Neilson J. *A guide to effective care in pregnancy and childbirth*. 2nd ed. Oxford, UK: Oxford University Press; 1995.
- Dublin S, Lydon-Rochelle M, Kaplan RC, Watts DH, Critchlow CW. Maternal and neonatal outcomes after induction of labour without an identified indication. *Am J Obstet Gynecol* 2000;**183**(4):986–94.
- Fraser W, Vendittelli F, Krauss I, Breart G. Effects of early augmentation of labour with amniotomy and oxytocin in nulliparous women: a meta-analysis. *Br J Obstet Gynaecol* 1998;**105**(2):189–94.
- Vahratian A, Zhang J, Troendle JF, Sciscione AC, Hoffman MK. Labour progression and risk of cesarean delivery in electively induced nullipara. *Obstet Gynecol* 2005;**105**(4):698–704.
- Lent M. The medical and legal risks of the electronic fetal monitor. *Stanford Law Rev* 1999;**51**(4):807–37.
- Hankins GD, MacLennan AH, Speer ME, Strunk A, Nelson K. Obstetric litigation is asphyxiating our maternity services. *Obstet Gynecol* 2006;**107**(6):1382–5.
- MacLennan A, Nelson KB, Hankins G, Speer M. Who will deliver our grandchildren? Implications of cerebral palsy litigation. *JAMA* 2005;**249**(13):1688–90.
- Johanson R, Newburn M, Macfarlane A. Has the medicalisation of childbirth gone too far? *BMJ* 2002;**324**(7342):892–5.
- Walker R, Turnbull D, Wilkinson C. Strategies to address global cesarean section rates: a review of the evidence. *Birth* 2002;**29**(1):28–39.
- Walker R, Turnbull D, Wilkinson C. Increasing cesarean section rates: exploring the role of culture in an Australian community. *Birth* 2004;**31**(2):117–24.
- Wildman K, Blondel B, Nijhuis J, Defoort P, Bakoula C. European indicators of health care during pregnancy, delivery and the postpartum period. *Eur J Obstet Gynecol Reprod Biol* 2003;**111**(Suppl 1):S53–65.
- Alfirevic Z, Edwards G, Platt MJ. The impact of delivery suite guidelines on intrapartum care in ‘standard primigravida’. *Eur J Obstet Gynecol Reprod Biol* 2004;**115**(1):28–31.
- Macdorman MF, Declercq E, Menacker F, Malloy MH. Infant and neonatal mortality for primary cesarean and vaginal births to women with “no indicated risk,” United States, 1998–2001 birth cohorts. *Birth* 2006;**33**(3):175–82.
- Laws PJ, Sullivan EA. Australia’s mothers and babies 2003. AIHW Cat. No. PER 29. Canberra: Australian Institute of Health and Welfare (Perinatal Statistics Series No. 16); 2005.
- Young D. Editorial: the push against vaginal birth. *Birth* 2003;**30**(3):149–52.

17. Klein MC, Sakala C, Simkin P, Davis-Floyd R, Rooks JP, Pincus J. Why do women go along with this stuff? *Birth* 2006;**33**(3):245–50.
18. Kitzinger S, Green JM, Chalmers B, Keirse M, Lindstrom K, Hemminki E. Why do women go along with this stuff? *Birth* 2006;**33**(2):154–8.
19. Goer H. Humanizing birth: a global grassroots movement. *Birth* 2004;**31**(4):308–14.
20. Maternity Care Coalition US. Childbirth at the Crossroads Roundtable event 2005. <http://www.momobile.org/events/session1-summary.html> [accessed November 6, 2006].
21. Anim-Somuah M, Smyth R, Howell C. Epidural versus non-epidural or no analgesia in labour. *Cochrane Database Syst Rev* 2005;(4).
22. Kotaska AJ, Klein MC, Liston RM. Epidural analgesia associated with low-dose oxytocin augmentation increases cesarean births: a critical look at the external validity of randomized trials. *Am J Obstet Gynecol* 2006;**194**(3):809–14.
23. Mayberry LJ, Clemmens D, De A. Epidural analgesia side effects, co-interventions, and care of women during childbirth: a systematic review. *Am J Obstet Gynecol* 2002;**186**(5 Suppl Nature):S81–93.
24. Patel RR, Peters TJ, Murphy DJ. Prenatal risk factors for Caesarean section. Analyses of the ALSPAC cohort of 12,944 women in England. *Int J Epidemiol* 2005;**34**(2):353–67.
25. Laws PJ, Sullivan EA. Report on the evaluation of the Perinatal National Minimum Data Set. AIHW Cat. No. PER 27. Sydney, Australia: AIHW National Perinatal Statistics Unit. Perinatal Statistics Series No. 14; 2004.
26. Roberts CL, Lancaster PA. Australian national birth weight percentiles by gestational age. *Med J Aust* 1999;**170**(3):114–8.
27. Roberts CL, Raynes-Greenow CH, Upton A, Douglas ID, Peat B. Management of labour among women with epidural analgesia. *Aust NZ J Obstet Gynaecol* 2003;**43**(1):78–81.
28. SPSS Inc.. *Statistical package for social sciences (SPSS) for windows*. Chicago, IL, USA: SPSS Inc.; 2003.
29. Middle C, Macfarlane A. Labour and delivery of 'normal' primiparous women: analysis of routinely collected data. *Br J Obstet Gynaecol* 1995;**102**(12):970–7.
30. Paterson CM, Chapple JC, Beard RW, Joffe M, Steer P, Wright CSW. Evaluating the quality of maternity service—a discussion paper. *Br J Obstet Gynaecol* 1991;**98**:1073–8.
31. Effect of low-dose mobile versus traditional epidural techniques on mode of delivery: a randomised controlled trial. Comparative Obstetric Mobile Epidural Trial (COMET) Study Group UK. *Lancet* 2001;**358**:19–23.
32. Lieberman E, Davidson K, Lee-Parriz A, Shearer E. Changes in fetal position during labour and their association with epidural analgesia. *Obstet Gynecol* 2005;**105**(5):974–82.
33. Patel RR, Peters TJ, Murphy DJ. Prenatal risk factors for Caesarean section. Analyses of the ALSPAC cohort of 12,944 women in England. *Int J Epidemiol* 2005;**4**(2):353–67.
34. Thorp JA, Hu DH, Albin RM, McNitt J, Meyer BA, Cohen GR, et al. The effect of intrapartum epidural analgesia on nulliparous labour: a randomized, controlled, prospective trial. *Am J Obstet Gynecol* 1993;**169**(4):851–8.
35. Eriksson SL, Olausson PO, Olofsson C. Use of epidural analgesia and its relation to caesarean and instrumental deliveries—a population-based study of 94,217 primiparae. *Eur J Obstet Gynecol Reprod Biol* 2006;**128**:270–5.
36. Taylor LK, Simpson JM, Roberts CL, Olive EC, Henderson-Smart DJ. Risk of complications in a second pregnancy following caesarean section in the first pregnancy: a population-based study. *Med J Aust* 2005;**183**(10):515–9.
37. Landon MB, Hauth JC, Leveno KJ, Spong CY, Leindecker S, Varner MW, et al. Maternal and perinatal outcomes associated with a trial of labour after prior cesarean delivery. *N Engl J Med* 2004;**351**(25):2581–9.
38. Thompson JF, Roberts CL, Currie M, Ellwood DA. Prevalence and persistence of health problems after childbirth: associations with parity and method of birth. *Birth* 2002;**29**(2):83–94.
39. Macarthur C, Glazener C, Lancashire R, Herbison P, Wilson D, Grant A. Faecal incontinence and mode of first and subsequent delivery: a 6-year longitudinal study. *BJOG* 2005;**112**(8):1075–82.
40. Torvaldsen S, Roberts CL, Bell JC, Raynes-Greenow CH. Discontinuation of epidural analgesia late in labour for reducing the adverse delivery outcomes associated with epidural analgesia. *Cochrane Database Syst Rev* 2004;(4). CD004457.
41. Lieberman E, O'donoghue C. Unintended effects of epidural analgesia during labour: a systematic review. *Am J Obstet Gynecol* 2002;**186**(5 Suppl Nature):S31–68.
42. Howell CJ, Dean T, Lucking L, Dziedzic K, Jones PW, Johanson RB. Randomised study of long term outcome after epidural versus non-epidural analgesia during labour. *BMJ* 2002;**325**:357–61.
43. Goetzl L, Cohen A, Frigoletto Jr F, Lang JM, Lieberman E. Maternal epidural analgesia and rates of maternal antibiotic treatment in a low-risk nulliparous population. *J Perinatol* 2003;**23**(6):457–61.
44. Hofmeyr G, Cyna A, Middleton P. Prophylactic intravenous preloading for regional analgesia in labour. *Cochrane Database Syst Rev* 2004;(4). CD000175.
45. Allen VM, O'Connell CM, Farrell SA, Baskett TF. Economic implications of method of delivery. *Am J Obstet Gynecol* 2005;**193**(1):192–7.
46. Roberts CL, Tracy S, Peat B. Rates for obstetric intervention among private and public patients in Australia: population based descriptive study. *BMJ* 2000;**321**(7254):137–41.
47. Tracy SK, Tracy MB. Costing the cascade: estimating the cost of increased obstetric intervention in childbirth using population data. *BJOG* 2003;**110**(8):717–24.
48. Hofmeyr GJ. Prophylactic intravenous preloading for regional analgesia in labour. *Cochrane Database Syst Rev* 2002;(2). CD000175.
49. Thacker SB, Stroup D, Chang M. Continuous electronic heart rate monitoring for fetal assessment during labour. *Cochrane Database Syst Rev* 2001;(2). CD000063.
50. Chalmers I, Zlosnik JE, Johns KA, Campbell H. Obstetric practice and outcome of pregnancy in Cardiff residents, 1965–1973. *Br Med J* 1976;**1**(6012):735–8.