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Obstetrical Interventions for Term First Births in the United States

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Abstract

Background—Labour induction and caesarean are increasingly done without clinical indication. However, little is known about the prevalence of such interventions, or the characteristics of women who receive them. We used the 2003 revision of the US birth certificates to summarise recorded interventions and to characterise maternal profiles associated with such interventions.

Methods—We carried out a retrospective study of 2.35 million primiparous women delivering singleton live births at 37–44 weeks in the United States, 2005–08. We used the 2003 revision of the birth certificate to define delivery categories: “indicated” were those with induced labour or pre-labour caesarean for hypertension, diabetes, chorioamnionitis, failed cephalic version at 40 weeks, growth restriction (<3rd centile), or postterm (≥ 42 weeks); those with prelabour caesarean with breech at 39 weeks; or those with caesarean with labour lasting ≥ 12 hours, failed trial of labour, vacuum/forceps extraction, or fetal intolerance to labour. Remaining deliveries with induction/caesarean were classified as “non-indicated” and all other deliveries “spontaneous.”

Results—Half of all term first births (50%) were delivered after intervention, and half of interventions were non-indicated (26% of all deliveries.) Women with interventions were more likely to deliver on a weekday. Non-indicated interventions were more common among socially advantaged women.

Conclusions—Nearly a quarter of US term first deliveries had an indicated intervention, and another quarter received intervention without a recorded clinical indication. Both numbers are probably underestimates.

Keywords

Obstetrical interventions; elective deliveries; caesarean delivery; labour induction

The practice of “elective” (or non-indicated) obstetric intervention has been increasing in the United States¹ and many other industrialised countries.^{2, 3} Such elective procedures presumably explain much of the 50% increase in caesarean deliveries in the US between 1998 and 2010 (from 21% to 33%),⁴ and the doubling of labour induction.^{1, 5} Changes in obstetric practice may also have contributed to the shift of mean gestational age in US from

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40 to 39 weeks, and to shifts in the proportion of preterm deliveries,^{6–8} although there are limited data to support such speculations.⁵

The impact of non-indicated caesarean delivery or labour induction on maternal and infant health is difficult to assess.^{2, 9–12} The reasons why pregnant women might undergo either of these interventions are often related to their underlying risk, which in turn affects the observed mortality and morbidity. Defining two components of obstetrical intervention – those with and those without recorded obstetrical indications – is at least a starting point in describing current obstetric practice.

The objectives of this study are two-fold: to describe the overall patterns of indicated, non-indicated, and spontaneous deliveries in a large, population-based sample, and to describe the maternal profiles and neonatal outcomes associated with the three types of delivery.

Material and Methods

Our analyses are based on vital statistics data for US births in 2005–08. These data were assembled by the National Center for Health Statistics of the Centers for Disease Control and Prevention, and cover the most recently available four-year period. These data correspond to the linked live-birth/infant death period data files, and are based on the 2003 revision of the birth and death certificates. This revised certificate of birth was used by 12 states in 2005 (Florida, Idaho, Kansas, Kentucky, Nebraska, New York (excluding New York city), Pennsylvania, South Carolina, Tennessee, Texas, and Washington), 19 states in 2006 (adding California, Delaware, North Dakota, South Dakota, Ohio, Vermont and Wyoming), 22 states in 2007 (adding Colorado, Indiana, and Iowa), and 27 states in 2008 (adding Georgia, Michigan, Montana, New Mexico, and Oregon)

We restricted the study to primiparous women who delivered a singleton live birth at 37–44 completed weeks of gestation. Gestational age (reported in completed weeks) in these data files was based on the “best obstetrical estimate” that was reported by the birth attendant and may have been based on a sonographic estimate of gestation. We excluded preterm deliveries because the great majority of such deliveries are presumed pathological, making distinctions between indicated or non-indicated delivery less meaningful.

Obstetrical Interventions

Vital statistics data do not distinguish births based on intervention status. We therefore developed algorithms using data from the revised birth certificate to divide live first births into indicated, non-indicated, and spontaneous deliveries in mutually exclusive and non-overlapping categories. Specifically, indicated deliveries were those in which labour had been induced or caesarean performed in the presence of any of the following conditions: gestational hypertension/preeclampsia and eclampsia; chronic hypertension; pregestational or gestational diabetes; chorioamnionitis; failed cephalic version at 40 weeks; postterm pregnancies at 42 weeks; or inferred fetal growth restriction (<3rd percentile birthweight for gestational age, based on internal standards). Indicated deliveries also included women who underwent a pre-labour caesarean in the presence of breech at 39 weeks;¹³ labour lasting at least 12 hours; failed trial of labour; fetal intolerance to labour; or failed vacuum or forceps extraction. All remaining caesarean deliveries or labour inductions (or both) were inferred to be “non-indicated.” All deliveries with neither a caesarean nor labour induction were classified as “spontaneous.”

Figure 1 provides the detailed algorithm used to classify deliveries into the three groups. Figure 2 shows how the three categories of delivery were distributed by type of labour

induction (spontaneous, non-indicated and indicated) and mode of delivery (vaginal, non-indicated caesarean, and indicated caesarean).

Statistical analysis

We performed two sets of analyses. In the first, we compared the maternal socio-demographic characteristics for indicated, non-indicated, and spontaneous delivery groups. Risk factors included maternal age, education (highest degree), race/ethnicity, marital status, and smoking during pregnancy. We examined the distribution of deliveries by day of the week. We also compared the distributions of medical and obstetrical complications in relation to the three delivery groups.

In the second set of analyses, we compared the risks of neonatal mortality and morbidity among the three delivery types. Mortality analyses were further stratified for early (0–6 days) and late (7–27 days) deaths. As measures of morbidity, we used five-minute Apgar score <4 (%), admission to the neonatal intensive care unit, newborns requiring ventilation support, or neonatal seizures, as well as a composite of these four morbidity measures.

Cohort composition

From 2005 to 2008 there were 8 557 769 singleton live births in the US registered using the 2003 revision of the birth certificate. This revised certificate provides more detailed – and standardised – data than earlier versions regarding the course of labour and delivery, and the procedures performed. The certificate also provides finer distinctions of medical and obstetrical complications (separation of pregestational from gestational diabetes, for instance.) Such details permit more refined definitions of delivery categories than has previously been possible for US national data. In order to eliminate possible effects of prior birth outcome or prior method of delivery on subsequent delivery decisions, we restricted analysis to births among primiparous women ($n=3\,080\,288$). Of these, we excluded 6.6% ($n=204\,387$) who were missing data on the obstetrical estimate of gestational age (mostly from California, which did not report these data in 2005–06), and 7.6% delivered before 37 weeks ($n=232\,632$). Finally, we excluded 0.2% births ($n=6564$) missing data on obstetrical complications or procedures performed during delivery. These exclusions left 2 350 388 (76%) singleton live births delivered at term to primiparous women.

Results

Profile of obstetrical interventions

Twenty-four percent of first births were with indicated interventions ($n=559\,382$), 26% were with non-indicated interventions ($n=613\,694$), and 50% were spontaneous deliveries ($n=1\,177\,312$) (Figs 1 and 2). The profile of obstetrical complications and neonatal outcomes in relation to the three types of deliveries is shown in Table 1. Obstetrical complications were most common among women with indicated deliveries, as would be expected given that such complications were among the criteria for indicated delivery. Women with non-indicated interventions had more breech presentations (before 39 weeks) than women with spontaneous delivery. The percent of births with non-indicated intervention increased from 20% at 37 weeks to 35% at 41 weeks (Fig 3).

Figure 4 shows the distributions of births by day of the week. Spontaneous births were the most evenly distributed across days of the week, with a slight decline during weekends. In contrast, indicated and non-indicated deliveries dropped sharply on weekends. This pattern did not vary by year of delivery, maternal education, race or marital status (data not shown.)

Obstetrical interventions and maternal risk profiles

The distribution of maternal socio-demographic risk factors in relation to delivery categories is shown in Table 2. Maternal age was strongly associated with type of delivery, with spontaneous deliveries declining from 56% to 30% with advancing age. Spontaneous deliveries also declined with higher maternal education, again with increases in both indicated and non-indicated deliveries. In general, both types of interventions were more prevalent among women who were older, white, married, with higher education, and who smoked during pregnancy.

Obstetrical interventions and neonatal outcomes

Neonatal mortality was 1.1 per 1000 in these term births to primiparous women. Neonatal mortality was 1.2 per 1000 for indicated, 0.7 per 1000 for non-indicated and 0.6 per 1000 for spontaneous deliveries. Babies with indicated deliveries had the highest risk of mortality across most gestational ages, while those delivered spontaneously had the lowest (Fig 5). Composite morbidity risk was 10.3% for indicated, 6.6% for non-indicated and 5.5% for spontaneous deliveries. These results were similar for the individual morbidity outcomes (data not shown).

We carried out a sensitivity analysis to examine the results after excluding births from California in 2007–08 (these births were excluded in 2005–06 since California did not report the obstetrical estimate of gestational age). The results of this sensitivity analysis were similar to the overall analysis.

Comment

Among 2.35 million singleton first births delivered at term in the US, only half were delivered spontaneously following natural onset of labour. Another 24% of births had accelerated delivery (induced labour, caesarean, or both) in the presence of recorded maternal or fetal pathology. The remaining 26% had accelerated delivery in the absence of recorded indications, and were presumed non-indicated.

Limitations of vital statistics records

The revised US birth certificate offers a new opportunity to describe the various categories of delivery for a large population base. However, data quality remains an important issue in any analysis of clinical practice based on vital statistics.¹⁴ There are inevitably errors in routinely collected records – both in complications that are recorded when no complication was in fact present, and (probably more likely) in complications that are left unrecorded. Furthermore, errors in recorded clinical data are probably not random with regard to social conditions of the mother or clinical conditions during labour and delivery. For all these reasons, it is important to consider the implications of incomplete and erroneous records on our results.

If obstetrical interventions (especially induction of labour) are more likely to be unrecorded than to be incorrectly noted,¹⁵ then our finding of 50% interventions is an underestimate. (It is highly unlikely that 50% is an overestimate.) Similarly, if indications for intervention are under-reported, then the finding of 23% of first births with indicated intervention is probably low.¹⁵ It is also possible that obstetrical indications may be recorded to justify intervention, in which case some “indicated” deliveries in our data should be “non-indicated,” and the 27% with non-indicated interventions would be an underestimate.

Finally, if data on interventions and indications are less completely recorded for deliveries among less socially advantaged women, such under-ascertainment could contribute to the

observed trends of decreased interventions (and more spontaneous deliveries) among less-educated, younger, non-white mothers. It would also follow that the proportion of interventions in the total population is even higher than we observe. However, we know of no evidence suggesting that underreporting on vital statistics is related to characteristics of the mother.

Other limitations

In addition to underreporting, clinical data on vital statistics records are limited by the level of detail provided on the form. For example, we could not identify women with a pre-labour caesarean for abruption, for praevia or accreta, or for oligo or polyhydramnios. Unrecorded risk factors leading to intervention would result in an underestimate of the percent of deliveries classified as indicated, and inflate the percent included in the non-indicated group.

Our definitions for indications involve grey areas that could easily be defined in other ways. Even so, the inevitable misclassification in these data underscores the difficulties of evaluating obstetrical interventions. More careful assessment of benefits and hazards would require either randomised clinical trials or large prospective cohort studies with careful data on medical and obstetrical complications and the procedures performed during labour and delivery.

Strengths of the data

These analyses were based entirely on data from states using the most recent (2003) revision of the vital records data. The large sample size adds to the stability of the findings. Furthermore, while our sample does not include all states in the US, it encompasses about half of all US births during this period, with broad geographic representation. When we excluded births from California in 2007–08 (California births in 2005–06 having already been excluded because the obstetric estimate of gestational age was not reported) the overall conclusions did not change.

Several previous studies have examined risks of perinatal mortality and morbidity in relation to non-indicated caesarean deliveries.⁹ However, we know of none that has explored the characteristics of women in the non-indicated delivery group. Furthermore, previous studies have restricted non-indicated interventions to non-indicated caesarean deliveries, without considering the closely related role of non-indicated labour inductions.^{5, 9} A combined category of non-indicated inductions and caesarean deliveries may more accurately reflect women's or physician's preference for delivery in the absence of specific indications.

The high prevalence of pregnancy interventions

For most of the history of obstetrics, interventions – and caesarean delivery in particular – have been reserved for situations in which the mother or fetus is endangered by a condition that would be made worse by the continuation of pregnancy.¹⁶ In such settings, the assumption is that the fetus has a better chance of survival outside the uterus.¹⁷ We found that almost a quarter of all first births (among mothers with no history of adverse delivery) are delivered for obstetrical indications. This implies that at least a quarter of all first pregnancies are regarded by obstetricians as “pathologic,” i.e., with conditions that justify intervention.

Furthermore, interventions are increasingly being carried out in the absence of clear or urgent indications. A 2006 NIH “*State-of-the-Science*” conference on “Caesarean delivery on maternal request,”¹⁸ as well as subsequent observational studies,¹⁹ have reported an increase in non-indicated primary caesarean deliveries in pregnancies lacking obvious medical or obstetrical indications. We found that 27% of first births had interventions during labour or

delivery without recorded indications for an intervention. To the degree that clinical indications have been under-reported, this percent of non-indicated intervention is over-estimated. In the other direction, the percent could be under-estimated if there has been underreporting of interventions in general, or if truly non-indicated interventions have been recorded as “indicated” (perhaps due to hospital policies or reimbursement requirements).

Characteristics of women with interventions

The profile of women who undergo interventions has not previously been described. In these US data, interventions (both indicated and non-indicated) were generally more frequent among socially advantaged women, and were more likely to take place during the regular work-week. The interpretation of these data is not entirely straightforward. It is possible that advantaged women exert more influence on the timing of their deliveries, and that interventions are truly more common in this group. It is also possible that interventions are more carefully noted in this group of women. The decrease of both types of interventions on weekends may reflect physician preference or hospital policies, but it also could indicate less complete recording of indications on weekends, when hospitals may be more short-staffed. The pattern of increased intervention with maternal age is consistent with the increased prevalence of obstetric risks with age (e.g., preeclampsia, obesity, in vitro fertilization).

Interventions and pregnancy outcomes

There are many observational studies of elective (non-indicated) caesarean deliveries and adverse perinatal outcomes.^{9, 10, 20–22} Even when no specific indication has been recorded, an intervention may be in response to some aspect of women’s underlying risk, which in turn increases the observed mortality and morbidity within the intervention group. Our observational data carry the same limitations. Non-indicated interventions had higher neonatal mortality and morbidity than spontaneous births at virtually every gestational age. Certain preexisting risk factors were more common among non-indicated interventions (e.g., breech presentation before 39 weeks), which suggests that some of these deliveries were in fact indicated in the opinion of the attending physician. The presence of such risk factors would add to the apparent risk with non-indicated deliveries by increasing the baseline risk among these women. In the other direction, we excluded from non-indicated deliveries those with extreme small size for gestational age or non-reassuring fetal status – high-risk conditions that were included in spontaneous deliveries. All of these limitations make it impossible to interpret the higher neonatal risks seen with non-indicated intervention.

Conclusions

Half of term births to primiparous women in the US underwent obstetrical intervention. Among those with interventions, more than half had no recorded clinical indication. Non-indicated interventions were more common among women with socio-economic advantages. Due to the inherent incompleteness of clinical information in vital statistics data, it is likely that the proportion of interventions is even larger than we observe.²³ Non-indicated interventions appear to be more common among women who are at a socio-economic advantage. The reasons for intervention in the absence of indications are complex. Women may be taking a stronger role in deciding their method of delivery, or their physicians may be more likely to suggest intervention in the presence of subtle clinical concerns. In addition, the evolving health care system, cultural influences, and patient demography are likely to influence the timing and method of delivery. With at least one quarter of first births in the US receiving non-indicated interventions, the assessment of its risks and benefits represents an ongoing challenge for the practice of obstetrics.

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Fig. 1. Algorithm to classify the type of delivery based on maternal-fetal indications, labour induction and caesarean delivery

Algorithm to classify the type of delivery (indicated, non-indicated and spontaneous) based on the presence or absence of maternal-fetal indications, labour induction and caesarean delivery. (Groups 3 and 9 are identical, as are groups 4, 10, and 12.) The figures in the extreme right column shows the percent of births in the various groups (summing to 100%)

Legend: Indications A-F listed in the figure are as follows: Induction of labour with any of the following indications (with or without subsequent caesarean): A. Chronic hypertension or gestational hypertension/preeclampsia, or eclampsia; B. Pregestational or gestational diabetes; C. chorioamnionitis; D. Failed cephalic version at 40 weeks; E. Inferred fetal growth restriction (birthweight <3 percentile for gestational age); F. Postterm (>42 weeks). Pre-labour caesarean delivery with any of the following: A through F above, plus: G. Breech at <39 weeks; H. Problems in labour and delivery (including fetal intolerance to labour; prolonged labour; failed trial of labour; and failed vacuum extraction or failed forceps)

Fig. 2.

Percent of births that fall within the eight cross-classifications of labour induction and mode of delivery. From the algorithm in figure 1, groups 1–3, 5 and 9 are classified as “indicated” deliveries; groups 6–8 and 11 as “non-indicated” deliveries; and groups 4, 10 and 12 are classified as “spontaneous labour and delivery”

Fig. 3.
Percent of births at each gestation week by birth type: United States singleton live births to primiparous women delivered at 37–44 weeks, 2005–08

Fig. 4. Distribution of birth type in relation to weekday of birth: United States singleton live births to primiparous women delivered at 37–44 weeks, 2005–08

Fig. 5.

Risks of neonatal mortality and composite neonatal morbidity (five-minute Apgar score <4, admission to the neonatal intensive care unit, assisted ventilation or neonatal seizures) based on delivery type: United States singleton live births to primiparous women delivered at 37–44 weeks, 2005–08

Table 1
Obstetrical complications and neonatal outcomes in relation to type of birth among women having their first births

	Total births	Birth type		1 177 312
		Spontaneous onset of labour and delivery		
		Interventions (n=1 173 076)		
		Indicated	Non-indicated	
Number of pregnancies	2 235 388	559 382	613 694	
Obstetrical complications				
Chronic hypertension (%)	19 371	2.7	—	0.4
Pre-gestational diabetes (%)	9942	1.4	—	0.2
Gestational diabetes (%)	72 461	9.0	—	1.9
Breech presentation (%)	68 129	8.4	3.3	0.2
Breech at 37–38 weeks (%)	28 989	5.8	12.3	0.3
Breech at 39–44 weeks (%)	39 140	9.3	—	0.2
Chorioamnionitis (%)	49 005	5.0	—	1.2
Gestational hypertension/preeclampsia (%)	110 089	15.5	—	2.0
Small for gestational age (<3 percentile) (%)	70 318	6.5	—	2.9
Fetal intolerance to labour† (%)	165 637	21.9	2.2	2.5
Labour induction (%)	697 204	49.5	58.5	—
Failed induction (%)				
Caesarean delivery (%)	696 907	84.3	36.7	—
Neonatal outcomes				
Neonatal mortality (per 1000)	2276	1.2	0.7	0.6
Early neonatal deaths (per 1000)	1370	0.7	0.4	0.3
Late neonatal deaths (per 1000)	906	0.4	0.3	0.2
Composite neonatal morbidity (%)	161 798	10.3	6.6	5.4
5-minute Apgar score <4 (%)	8522	0.6	0.3	0.3
Admission to the NICU (%)	77 378	5.4	2.9	2.5
Assisted ventilation support (%)	97 606	6.1	4.2	3.3
Neonatal seizures (per 1000)	809	0.6	0.3	0.3

* Interventions include labour induction or prelabour caesarean

Dash indicates that these categories were used to develop the algorithm to distinguish the three birth types

Table 2

Distribution of maternal characteristics in relation to birth type

	Total births	Birth type		
		Interventions		Spontaneous onset of labour and delivery
		Indicated	Non-indicated	
Number of pregnancies	2 235 388	559 382	613 694	1 177 312
Period of birth				
2005	369 281	25.4	25.8	48.8
2006	440 701	25.4	26.6	48.1
2007	711 930	22.8	26.3	51.0
2008	828 476	23.1	25.9	51.0
Maternal age (years)				
<20	546 286	18.4	25.0	56.6
20–24	731 597	22.6	25.9	55.1
25–29	587 264	25.4	26.3	48.3
30–34	337 006	28.3	26.6	45.1
35–39	124 943	32.4	28.9	38.7
40	23 292	35.9	32.7	31.4
Education (highest degree)				
<8 th grade	95 127	19.0	19.9	61.0
High school	1 015 932	22.1	25.3	52.7
Some college	1 012 026	25.7	27.5	46.8
Master's degree or higher	227 303	25.0	26.4	48.6
Maternal ethnicity				
Caucasian	1 435 484	25.1	27.4	47.5
African-American	276 164	25.4	23.5	51.1
Hispanic	622 931	20.2	24.4	55.4
Other races	15 809	21.3	23.8	54.9
Marital status				
Single	1 126 297	22.1	25.3	52.6
Married	1 224 091	25.3	26.9	47.8
Maternal smoking				
Non-smoker	1 786 433	23.0	26.1	50.9
Smoker (any)	1 224 091	26.7	26.7	46.6
Weekday of birth				
Weekday	1 845 575	24.7	28.2	47.1
Weekend	504 813	20.5	18.4	61.1
Gestational age (weeks) [†]	39.2 (1.1)	39.2 (1.2)	39.3 (1.1)	39.1 (1.1)

[†]Data reported as mean (standard deviation)