

Patient Education and the Response to New Medical Research

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Abstract:

We examine the impact that medical research published in peer-reviewed journals has on the practice of medicine. We exploit the release of a recent *New England Journal of Medicine* article which demonstrated that the risks of attempting a vaginal birth after having a previous C-section birth (VBAC) were higher than previously thought. We find that immediately following this article, the national VBAC rate dropped by 16 percent and this response was largest among more educated mothers (particularly those with graduate degrees).

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1. Introduction

Consumers have access to a number of sources of information when making medical decision. These sources include physician or hospital medical report cards, direct-to-consumer advertisements, warning labels placed on medications, FDA drug withdrawals, and medical studies. Vast sums of public money are spent on medical research that produces new medical information, as well as on the collection and dissemination of quality reports about health care providers to the public. In theory, providing more information will allow patients to receive the most appropriate and cost-effective treatment. However, we do not adequately understand how new medical information affects medical decisions (Phelps, 1992; Lee et al, 1995; Weingarten, 1997).

Past economic studies find some evidence that people are responsive to new information when making medical decisions. Azoulay (2002) finds that the sales of prescription drugs increase in response to both new scientific evidence and increased marketing. Pope (2006) finds that non-emergency patients are more likely to attend hospitals that receive a higher ranking in US News and World Report, and Cutler et al (2004) find that hospital patient volume responds to medical report cards. Wosinska (2005) finds that DTC advertising of prescription drugs increases compliance with drug therapy and Avery et al (2007) find that DTC advertising of nicotine replacement therapies leads to more smokers seeking to quit, sometimes even without the use of advertised pharmacotherapies.

It is surprising that we do not adequately understand how information from new medical studies affects medical decisions since so much public funding and human effort is devoted to providing this type of information. For example, there are 4,000 medical journals indexed on Medline. Many of the published studies involve decisions between

two treatments that are already available, often at the same cost. If one treatment is objectively better, and information can lead people to the appropriate treatment, this could lead to an increase in healthy outcomes with very little additional cost to society.

Most of the small body of economic studies that look at consumer response to new medical information have not examined whether the response differs by education. Exceptions include Lleras-Muney and Lichtenberg (forthcoming), who find an education gradient in how quickly people use a drug after it has been approved by the FDA, and Mathios (2000) who finds no relationship between the drop in demand for salad dressings with higher fat content in response to federal law requiring nutritional labeling and the average education of the customers at a given store location.

We examine the response to medical findings published in July 2001 in the *New England Journal of Medicine* (Lydon-Rochelle et al, 2001) that found an increased risk of having a vaginal birth after a caesarean (VBAC). The article was reported by National Public Radio on July 3, 2001 and was carried by newspapers all across the country under the headline “Labor Risky After Cesarean.” Using US birth certificate data, we find that in a three month period following the release of the article, the national VBAC rate dropped by 16 percent (from 19 percent of those with prior caesarean deliveries giving birth vaginally for their current birth, to 15.9 percent). In several states, the VBAC rate dropped over 30%. This response was largest among younger and more educated mothers. The NEJM article also indicated that VBACs were particularly risky if the labor was induced. We find similar large drops in the probability that women with previous C-sections had their labor induced, with the largest response again concentrated among younger and more educated mothers.

2. VBACs in the US

In 2000, 22.9% of all births in the US occurred through caesarean section (C-section). Among those births to mothers who have had a prior C-section, 79.4% will be delivered by C-section. In fact, until the development of the low transverse incision in the 1970s, the US medical profession adopted a policy that all women who had experienced a previous caesarean would automatically receive a caesarean for all subsequent births. In layman's terms, this policy came to be known by the mantra "once a Caesarean, always a Caesarean". In 1981, the national VBAC rate was only 3% (Harer, 2002).

The major concern in allowing women with a previous C-section to attempt a VBAC is the increased risk that the uterus will rupture near the scar site of the incision. In the event of a uterine rupture, the baby must be delivered immediately by C-section. If not, the rupture cuts off the blood supply to the baby and can potentially kill the mother if the bleeding is not stopped. There is also some concern that if the uterus cannot be properly repaired, the mother will require a hysterectomy (thus preventing future births).

From a policy perspective, one concern about the rise in the caesarean rate is the additional healthcare costs that it involves. Keeler and Brodie (1993) found that in 1989, the physician's charge alone was on average \$500 more to perform a C-section birth as opposed to a vaginal birth. Gruber et al (1996) find that this difference depends on the patient's insurance status, with physicians receiving \$561 more to perform a C-section for patients with private insurance and only \$127 more for patients with Medicaid.

These types of cost savings led many managed healthcare organizations in the 1990s to adopt pro-VBAC practices. In 1995 the American College of Obstetricians and Gynecologists (ACOG) released guidelines that suggested that women with only one previous C-section who had a lower transverse uterine incision should be encouraged to

have a VBAC. As a result the VBAC rate reached its highest point of 28.3% in 1996 (Menacker and Curtain, 2001). In 1993, Los Angeles County University of Southern California Medical Center adopted a policy that any mother who had the low-risk factors mentioned in the ACOG guidelines would have to have a VBAC. This policy led to 49 lawsuits and a payout of \$24 million by 1997 with millions more expected to be paid from cases in which the baby died during the procedure (Harer, 2002). These types of legal concerns led to a steady decline in the VBAC rate starting in 1997.

The downward trend in VBAC rates since 2000 is shown in panel A of Figure 1, which plots the rate in monthly increments for the years 2000–2002, separately for women with at least a four-year college degree (“college”) and those without any college education (“no college”). Over this period, the VBAC rate dropped from around 23% in January 2000 to 12% in December 2002, a 48% decrease. Figure 1 also shows that the VBAC rate had been traditionally higher among college educated women than among women with no college education until July 2001, at which point both rates declined sharply and converged. The VBAC rate decreased more sharply among college educated mothers among mothers without a college degree. Panel B in Figure 1 shows a similar pattern for whether the mother had her labor artificially induced, though the educational gaps before July 2001 were much larger.

The major drop in the VBAC rate directly followed the release of a *New England of Medicine* article in July 2001 (Lydon-Rochelle et al, 2001), showing that mothers with a previous C-section were more likely to experience a uterine rupture if they attempted a trial of labor (0.58%) than if they had an elective repeat C-section (0.16%). The article also indicated that mothers who had their labor induced were even more likely to experience a uterine rupture (0.77%), especially if they were induced with the hormone

prostaglandins (2.45%). We use the change in the VBAC rate following the publication of this article to examine how the response to new medical research differs based on the education of the patient.

While not the focus of this paper, there was an additional article published in the *Journal of the American Medical Association* by Smith et al. (2002) that came to similar conclusions about the relative risk of attempting a trial of labor. One of our additional checks examines the response to this second article.

2. Conceptual framework and testable hypotheses

We motivate our analysis of the differences in response by socioeconomic status with a simple conceptual discussion. We assume that patients and physicians jointly decide on the method of child delivery, taking into consideration the costs and benefits of each procedure. Patients and physicians may have preferences (practice patterns) that are formed over time, but are updated in response to new information. As with other medical news, we expect that the response to Lydon-Rochelle et al (2001) will vary based on many factors, including the strength of prior preferences on the part of the decision makers, the pressures of insurers, and peer group effects. A full investigation of these competing response pathways would require richer data than birth certificates contain. However, economic theory suggests that socioeconomic distinctions, such as educational attainment, may also influence health behavior. Grossman (1974) asserts that education may have an allocative effect on health production partly through the incorporation of information.

Grossman's theory has been tested in a number of studies that find evidence to support it. For example, Lleras-Muney and Lichtenberg (forthcoming) find that more

highly educated people are quicker to adopt drugs recently approved by the FDA. This finding holds, after controlling for the income and insurance status of the individual, thus netting out the indirect effects of education through increased access (something which we also do by looking at a low cost decision, such as having labor induced). They support their findings with survey data from the National Science Foundation, showing that people with a college degree were more likely to understand the nature of scientific inquiry, and they were more likely to state that they were interested and well-informed about new medical discoveries. In a similar vein, we hypothesize that those with more education will incorporate new medical information faster in child birth decisions. Note that our methodology is unable to discern whether this occurs through the mother's direct absorption of new medical research via media or other informational channels, through the sorting to providers who are more informed about new medical information or more willing to adjust their practices, or if the change comes through other mechanisms. In each of these plausible circumstances, education plays an allocative role in improving health, an issue to which we return in the discussion.

We test our hypothesis that better educated patients will more quickly adapt to new medical information by comparing the VBAC and labor trial rates before and after the release of the NEJM article, for women of higher vs. lower education levels, controlling for other individual characteristics that are determinants of birth procedures. Specifically, we estimate equations of the following form:

$$P(Y_i = 1) = \beta_0 + \beta_1 \cdot post_i + \beta_2 \cdot education_i + \beta_3 \cdot education_i \cdot post_i + X_i \cdot \gamma + e_i$$

Y is an indicator for whether the mother experienced a VBAC (or alternatively had her labor induced), among those women who have had a prior C-section and thus are

candidates for a VBAC. Post refers to births occurring in the three-month period following the Lydon-Rochelle et al (2001) article. Education is measured as a set of four indicators (with less than high school degree being the omitted group) and X is a set of our covariates, including state or county fixed effects. X also includes an interaction between the post-period and all other maternal characteristics (excluding the medical risk factors), allowing those characteristics to have different influences on birth procedures over time. The key estimate of interest is β_3 , which shows whether higher educated mothers' response to the article differs from that of lower educated mothers.

3. Data

Our analysis uses US Natality Data from the National Vital Statistics System of the National Center for Health Statistics (NCHS). These data comes from birth certificates that are filed with vital statistics offices in each state. We restrict our sample to all full-term births that occurred after 37–43 weeks of gestation (a restriction similar to past studies, e.g. Smith 2002), and to mothers who have had a prior C-section and are thus eligible to attempt a VBAC. We focus on the three-month periods immediately before and after July 2001. Our sample contains 58,858 births to mothers with previous C-sections in the pre-period (April–June) and 61,703 in the post-period (August–October).

Table 1 provides the full set of controls used in our analysis, along with basic summary statistics for both the pre- and post- periods. Maternal education is reported in 17 categories on the natality files, which we collapse down to five groups: less than high school degree, high school degree, some college, four-year college degree, and graduate-school degree. We divide the mothers into four groups based on their race/ethnicity: non-Hispanic white, black, Hispanic, and other race. We include controls for the mother's age

(in years), the birth order of the child (linear), binary indicators for whether the mother is married and whether it is a plural birth (i.e. twins, triplets, etc). We also include controls for the 16 medical risk factors recorded in the natality data, such as whether the mother has diabetes or chronic hypertension (both of which are associated with lower VBAC rates).

The second two columns in Table 1 provide the probability of a VBAC among particular subgroups. For example, it is very unlikely (only a 4–5% chance) that a mother with a plural birth will have a VBAC, but more likely (29–33%) for a woman who has had a previous pre-term or small-for-gestation baby. Table 2 expands on the differences by education in the pre and post-period and provides some initial descriptive analysis of the changes that occurred in the VBAC and induced labor rates for each of the education groups between the pre and post-period. In the pre-period there is a U-shaped pattern between education and the VBAC rate—mothers without a high school degree are most likely to have a VBAC, mothers with some college are least likely to have a VBAC, but only slightly less than mothers who have completed college. However, the lower educated women are also less likely to receive any type of specific medical intervention in labor. The second panel in Table 2 shows that less educated women are much less likely to have their labor induced.

When we look at the changes in these rates between the pre and post-period, we find that the largest changes (both in absolute terms and in percentage change) occurred among the mothers with the highest level of education. The changes were particularly high for the set of women with a graduate degree, who saw a 22% drop in the VBAC rate and a 29% drop in the rate of induced labor. The corresponding changes for women with less than a high school degree were only 14% and 15%.

The regression analysis in the next section follows this same before-and-after approach, but adjusts the comparisons for the medical risks and county characteristics that may differ across mothers with different levels of education. For example, women with at least a college degree are more likely to have a plural birth (twins or triplets), but less likely to have diabetes or pregnancy-associated hypertension.

4. Results

In Table 3, we present the results from our primary regression specification that tests whether the response to the release of the new medical research differed by maternal characteristics, such as age, education, race, marital status (a proxy for material well-being), number of previous births, and whether the mother carried multiple fetuses (i.e. twins, triplets, etc.). The time period of the study is limited to three months before and three months after the publication of the study by Lydon-Rochelle et al (2001), thus capturing the short-term effects. The first column results are from a model that includes state fixed effects to control for the legal climate at the state level that influences the viability of attempting a VBAC (e.g. the prevalence of managed care and differences in Medicaid reimbursement policies for vaginal vs. Cesarean deliveries, as well as medical norms and preferences). The VBAC rate differed widely across states during the pre-period, with some states, such as Vermont, having a VBAC rate of over 40% and other states, such as Nevada, having a VBAC rate of only 15%.

The second column in Table 3 includes fixed effects for the county in which the mother delivers her baby. This captures differences in the attitudes and practices towards VBACs in a more narrowly-defined area than the entire state. Most medical malpractice cases are based on common community practices, so VBAC rates across counties within

the same state also vary widely. The county fixed effects also controls for some of underlying unobservable differences in mothers in different counties that might influence their desire for a VBAC. This also captures differences in quality of healthcare between richer and poorer counties. The sample size drops from 172,595 to 102,098 when including county fixed effects, because county identifiers are not reported in natality data for counties with a population less than 100,000. Thus, this also reflects estimates from a more urban population¹.

As a second dependent variable, we look at whether labor was induced, which Lydon-Rochelle et al (2001) found led to the highest medical risk for women with a previous C-section. As Table 2 shows, induced labor VBACs occur at a lower frequency among women with the least education in the pre-2001 period, a pattern that does not generally hold for VBACs. Looking at induced labor provides an example of a low cost medical procedure for which the educational pattern in the pre-period differs from the educational pattern of the VBAC rate in the same period.

The results show that the drop in the VBAC rate was greatest among women with the most education and those who were younger, with some evidence that black mothers showed a smaller response. When using county fixed effects, women with graduate degrees saw a change in their VBAC rate that is 3.1 percentage points greater than the change among women who did not finish high school. The overall VBAC rate also changed by 3.1 percentage points, highlighting just how large the educational gaps are in the response to new information. Though the changes are of a smaller magnitude, similar

¹ We also carry out an analysis where we include just state fixed effects for the sample of patients for which we have county identifiers (i.e. the bigger counties), and find that the results are very similar to the results using county fixed effects. This indicates that differences between our results using state and county fixed effects are due to differences between small and large counties (as we cannot include county fixed effects for smaller counties), rather than due to the decision of which level of fixed effect we use.

patterns exist among women with lower levels of education. The response following a monotonic pattern in both the likelihood of having a VBAC and of having labor induced.

We also find that younger mothers were more responsive to new medical information than their older counterparts. Holding education constant, an age gap of 23 years produces a difference in the VBAC rate equivalent to the gap in response between a mother with a graduate degree and a mother who did not complete high school. This age differences in response to new information are similar to patterns in the adoption of new technologies, such as the internet (Goldfarb and Prince 2008). We find no significant differential responses based on other maternal characteristics, such as marital status, number of previous children, plural birth, and ethnicity, although there is some evidence when using state fixed effects that the VBAC rate among black mothers was less responsive to the new information.

To ensure that our results are not driven merely by preexisting time trends, we implement a set of placebo tests similar in nature to that of Bertrand et al (2005). We replicate the analysis from Table 3 for every possible three month interval between April 1998 and September 2002 (42 separate regressions). While we observe significant drops in the VBAC rate in these months (there is a downward trend over the whole period), the only two points in time in which we find a significant difference in the change in the VBAC rate based on the mothers' education occurred on July 2001 (the article examined in this paper) and May 2002 (the JAMA article that confirmed the earlier results).

We also carry out a falsification test in which we conduct our original analysis (using the original pre/post timing measures as in Table 3) on the set of women who have had a previous child but have not had a previous C-section, as well as on first-time mothers. The results found in Lydon-Rochelle et al (2001) pertained only to the risks

faced by women with a previous C-section, and make no recommendations about the advisability of having a first-time C-section.

Table 4 provides the results for three of the placebo tests and two falsification tests. It shows that in only one case (which is well within what we would expect with 40 coefficients) is there a significant coefficient on the interaction between the post-period and maternal education. This means that while the VBAC and C-section rate were changing across each of these periods, there were no systematic differences in the change based on the mothers' education. This provides evidence that the differential response in July 2001 is not simply picking up a time trend that always differed by education.

Finally, we extend our analysis to include multiple three-month time periods, both before and after the release of the NEJM article, so that we can observe the effects of the July 2001 article beyond the immediate period. We divide the mothers into two educational groups, those with a four-year college degree and those with no college (we omit those with some college to provide a sharper contrast between the two groups). We carry out the same analysis as before, but now include indicator variables for the four three-month periods before and after July 2001. Thus, our analysis extends from July 2000 to July 2002, allowing us to comment on the immediate as well as medium range response.

The coefficients on the main effects for each period show that the risk-adjusted VBAC rates declined across every period in our analysis, with the biggest drop occurring in the period immediately after July 2001. The interactions between college graduates and the time periods before July 2001 indicate that there was already a differential trend in the VBAC rate, such that the VBAC rates were starting to converge prior to the release of the article. However, the largest change in these educational gaps occurred in the first

three months after the article, with the educational gap in the response slowly decreasing in the ensuing months. The changes in the rates of labor induction follow a similar pattern, except that it appears the initial response took a little longer to develop, with the largest gap in the educational differences occurring 4–6 months after the release of the article.

5. Possible Mechanisms

There are at least three mechanisms that explain why more educated mothers experience a larger and quicker response to new medical information. First, more educated mothers may be better able to access and act on new information themselves. Second, more educated mothers may go to doctors that are more responsive to the new information. Third, education may just be a proxy for income and social class which provides access to the doctors who are better able to respond to the information. Distinguishing between these explanations is important in terms of understanding the relative benefit of public health policy geared at either informing the public about new medical knowledge (through public awareness campaigns), helping patients find the right doctor (through increased access or medical report cards) or increasing access to quality medical providers through subsidized health care.²

While we are unable to separate the relative magnitude of these different channels in this paper, future research could disentangle these various channels using hospital discharge records with physician identifiers and information on the patients' education and birth procedures. If the educational gaps in the response to new medical research are

² These channels are very similar to those described by Glied and Lleras-Muney (forthcoming) as mechanisms through which technological innovations may affect the relationship between education and health.

due to the decisions of patients, then among the patients going to a particular doctor we would observe a larger response among the more educated patients. If instead the differential response is due to more educated mothers sorting into doctors who are more responsive to the new medical research, then we would expect to see doctors with the larger response to the new medical research would attract more educated patients and that lower educated patients who happened to have a responsive doctor would experience a similar response as the more educated patients being attended by the same doctor.

6. Conclusion

We study the impact that medical research has on the use of birth procedures by exploiting the release of a *NEJM* article that brought new information to light on the risks of vaginal birth after a previous C-section (VBAC). Our results indicate that it was the more educated women who experienced the largest change in treatment in response to the new medical information. While the absolute risks at stake in a VBAC procedure are fairly small in magnitude (less than 1 percent chance of uterine rupture), our results show that knowledge of even this small difference is enough to change medical behavior. This finding builds on theory and an existing literature by showing that the adoption of new medical technology differs by education. This differential response to both new information and new technology might help explain the educational gaps in health that occur in the US. Future research is needed to explore the mechanisms by which these educational differences occur, investigating the relative role of the physicians and patients in making decisions in response to new advances.

References

- Avery, R. J., D. Kenkel, D. Lillard, and A.D. Mathios. Private Profits and Public Health: Does Advertising of Smoking Cessation Products Encourage Smokers to Quit? *Journal of Political Economy* 2007; 115; 447-481
- Azoulay, P. Do Pharmaceutical Sales Respond to Scientific Evidence? *Journal of Economics & Management Strategy* 2002; 11; 551-594.
- Bertrand, M., E. Duflo, and S. Mullainathan. How Much Should We Trust Differences-in-Differences Estimates? *Quarterly Journal of Economics* 2004; 119; 249-275.
- Cutler, D., R. Huckman and M. Landrum. The Role Of Information In Medical Markets: An Analysis Of Publicly Reported Outcomes In Cardiac Surgery. *American Economic Review* 2004; 94; 342-346.
- Glied, S., and A. Lleras-Muney. (2008). "Health Inequality, Education, and Medical Innovation." *Demography* 2008; 45; 741-761.
- Goldfarb, A. and J. Prince. Internet Adoption and Usage Patterns are Different: Implications for the Digital Divide. *Information Economics and Policy* 2008; 20; 2-15.
- Grossman, M. On the Concept of Health Capital and the Demand for Health. *The Journal of Political Economy* 1972; 80; 223-255.
- Gruber, J. J. Kim, D. and Mayzlin. Physician Fees and Procedure Intensity: The Case of Cesarean Delivery, *Journal of Health Economics* 1999; 18; 473-490.
- Harer, W. B. (2002). Vaginal Birth After Cesarean Delivery. *Journal of the American Medical Association* 2002; 287; 2627-2630.
- Keeler, E. and M. Brodie. Economic Incentives in the Choice between Vaginal Delivery and Cesarean Section. *The Milbank Quarterly* 1993; 71; 365-404.
- Lee, T. H., S.D. Pearson, and P.A. Johnson. Failure of information as an intervention to modify clinical management. *Annals of Internal Medicine* 1995; 122; 434-437.
- Lleras-Muney, A. and F. Lichtenberg. (forthcoming). "The Effect Of Education On Medical Technology Adoption: Are The More Educated More Likely To Use New Drugs?" *Annales d'Economie et Statistique*.
- Lydon-Rochelle M, V.L. Holt, T.R. Easterling, and D.P. Martin. Risk of uterine rupture during labor among women with a prior cesarean delivery. *New England Journal of Medicine* 2001; 345; 3-8.
- Mathios, A. The Impact of Mandatory Disclosure Laws on Product Choices: An Analysis of the Salad Dressing Market." *Journal of Law and Economics* 2000; 43; 651-677.

Menacker F., and S.C. Curtin. Trends in cesarean birth and vaginal birth after previous cesarean, 1991-99. National Vital Statistics Reports 2001; 49; 1-15.

Phelps, C. Diffusion of Information in Medical Care. The Journal of Economic Perspectives 1992; 6; 23-42.

Pope, D. "Reacting to Rankings: Evidence from 'America's Best Hospitals and Colleges'", Working Paper, UC Berkeley Economics Department. (2006)

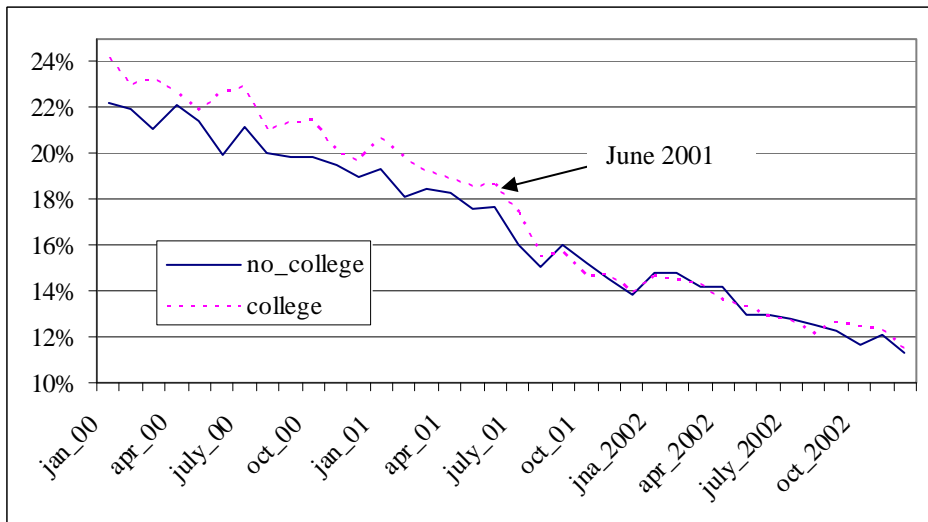
Smith G., J. Pell, A. Cameron, and R. Dobbie. (2002). "Risk of Perinatal Death Associated with Labor After Previous Cesarean Delivery in Uncomplicated Term Pregnancies." Journal of the American Medical Association 2002; 287; 2684-2690.

Weingarten, S. R. Practice guidelines and prediction rules should be subject to careful clinical testing. Journal of the American Medical Association 1997; 277; 1977-1978.

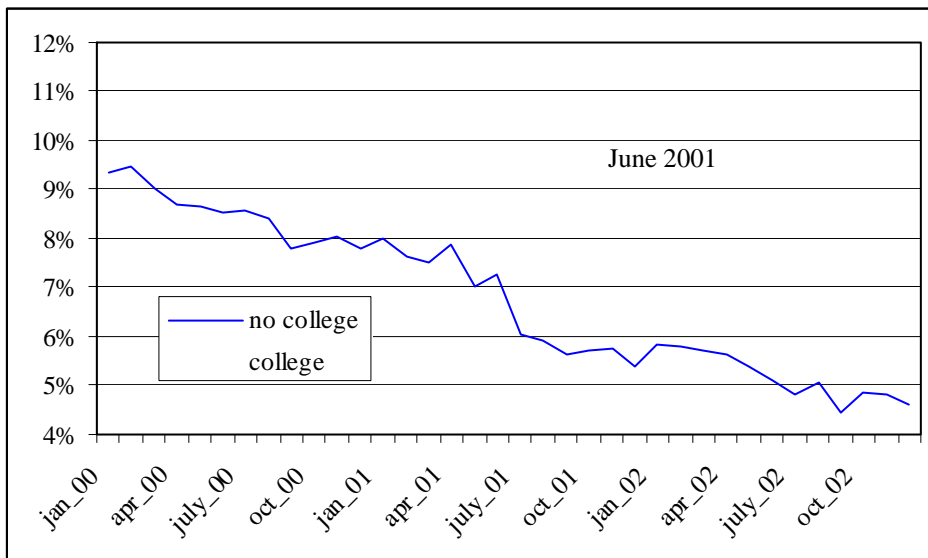
Wosinska, M. Direct-to-Consumer Advertising and Drug Therapy Compliance. Journal of Marketing Research. August 2005

Figure 1. National VBAC rate and induced labor rate by education level of mother

A. VBAC rate



B. Induced labor rate



Source: National Center for Health Statistics (2000-2002). The sample consists of women who completed a college degree (“college”) and women with no more than a high school diploma (“no college”). We omit all of the mothers with just some college education to provide a clearer contrast.

Table 1. Summary Statistics of Mother's Characteristics for Three Months Before and After July 2001.

Characteristics	Mean [Std]		P(VBAC Characteristic = 1)	
	Pre	Post	Pre	Post
Education:				
High school drop-out	0.166	0.179	0.213	0.184
High school degree	0.316	0.323	0.179	0.151
Some college	0.238	0.231	0.182	0.150
Four year college degree	0.168	0.160	0.199	0.166
Graduate degree	0.102	0.096	0.197	0.153
Age	29.80 [5.61]	29.78 [5.67]		
Married	0.760	0.749	0.189	0.157
Birth order	2.66 [0.93]	2.67 [0.94]		
Plural birth	0.018	0.018	0.056	0.042
Race				
White	0.637	0.613	0.194	0.159
Black	0.151	0.158	0.179	0.159
Hispanic	0.170	0.186	0.181	0.153
Other race	0.041	0.042	0.219	0.195
Risk Factor				
Cardiac disease	0.007	0.007	0.223	0.176
Lung disease	0.015	0.015	0.232	0.183
Diabetes	0.049	0.052	0.140	0.098
Genital herpes	0.011	0.011	0.228	0.181
Hydramnios	0.013	0.011	0.190	0.157
Hemoglobinopathy	0.001	0.001	0.169	0.132
Chronic hypertension	0.012	0.012	0.133	0.098
Pregnancy associated hypertension	0.029	0.027	0.158	0.115
Eclampsia	0.002	0.002	0.140	0.148
Incomplete cervix	0.003	0.003	0.179	0.157
Previous infant of 4000+ grams	0.026	0.025	0.233	0.194
Previous preterm or Small-for-gestation baby	0.020	0.020	0.333	0.289
Renal disease	0.003	0.003	0.204	0.214
Rh sensitization	0.007	0.007	0.222	0.167
Uterine bleeding	0.005	0.005	0.244	0.155
N	85,977	91,068		

Note: Sample includes all births in the US for April-June and August-October 2001 to mothers with a previous C-section.

Table 2. VBAC and Labor Induction rates for Three Months Before and After July 2001.

A. VBAC	N	Pre	Post	Change	%Change	t-stat
Graduate school	17,394	0.1965	0.1529	-0.0437	-0.222	7.60
College degree	28,772	0.1988	0.1656	-0.0332	-0.167	7.31
Some college	41,267	0.1820	0.1500	-0.0320	-0.176	8.75
HS degree	56,202	0.1786	0.1514	-0.0271	-0.152	8.68
Drop-out	30,353	0.2126	0.1838	-0.0287	-0.135	6.28
Overall	174,104	0.1904	0.1593	-0.0310	-0.163	17.08

B. Labor was Induced	N	Pre	Post	Change	%Change	t-stat
Graduate school	17,334	0.0915	0.0649	-0.0266	-0.291	6.53
College degree	28,675	0.0921	0.0705	-0.0216	-0.235	6.71
Some college	41,125	0.0938	0.0732	-0.0207	-0.221	7.60
HS degree	56,018	0.0836	0.0644	-0.0192	-0.229	8.68
Drop-out	30,270	0.0742	0.0628	-0.0114	-0.154	3.94
Overall	173,538	0.0867	0.0672	-0.0196	-0.226	15.32

Notes: The pre and post-period each refer to the three-month window before and after July 1, 2001, the date of publication of Lydon-Rochelle et al (2001). The sample consists of all US births during these two periods to mothers with a previous C-section.

Table 3. Response of VBAC and Labor Induction Rates to Lyndon-Rochelle et al. (2001)

	VBAC		Induced Labor	
Post	-0.0494**	-0.0502**	-0.0278**	-0.0405**
	[0.0110]	[0.0153]	[0.0079]	[0.0106]
post · HS degree	-0.0045	-0.0112	-0.0100*	-0.0096
	[0.0056]	[0.0076]	[0.0040]	[0.0053]
post · some college	-0.0098	-0.0187*	-0.0118**	-0.0092
	[0.0062]	[0.0084]	[0.0045]	[0.0058]
post · college degree	-0.0142*	-0.0268**	-0.0147**	-0.0163*
	[0.0072]	[0.0093]	[0.0051]	[0.0065]
post · graduate school	-0.0221**	-0.0310**	-0.0191**	-0.0184*
	[0.0081]	[0.0103]	[0.0058]	[0.0072]
post · age	0.0010**	0.0013**	0.0006*	0.0008*
	[0.0004]	[0.0005]	[0.0003]	[0.0003]
post · married	-0.0018	-0.0016	0.0018	0.0024
	[0.0048]	[0.0064]	[0.0034]	[0.0045]
post · order	-0.0019	-0.0016	0.0001	0.0017
	[0.0020]	[0.0026]	[0.0014]	[0.0018]
post · plural birth	0.0102	0.0140	0.0035	0.0015
	[0.0134]	[0.0171]	[0.0096]	[0.0120]
post · black	0.0163**	0.0123	0.0062	0.0049
	[0.0054]	[0.0069]	[0.0039]	[0.0048]
post · hispanic	0.0052	-0.0003	0.0034	0.0019
	[0.0051]	[0.0064]	[0.0037]	[0.0045]
post · other race	0.0117	0.0096	0.0031	-0.0029
	[0.0090]	[0.0111]	[0.0064]	[0.0077]
HS degree	-0.0078	-0.0066	0.0110**	0.0102**
	[0.0041]	[0.0056]	[0.0029]	[0.0039]
some college	0.0060	0.0012	0.0233**	0.0194**
	[0.0045]	[0.0061]	[0.0032]	[0.0043]
college degree	0.0413**	0.0378**	0.0281**	0.0262**
	[0.0052]	[0.0068]	[0.0037]	[0.0047]
graduate degree	0.0448**	0.0375**	0.0285**	0.0245**
	[0.0058]	[0.0075]	[0.0042]	[0.0052]
Age	-0.0065**	-0.0071**	-0.0022**	-0.0021**
	[0.0003]	[0.0004]	[0.0002]	[0.0002]
Order	0.0109**	0.0081	0.0035	0.0033
	[0.0035]	[0.0047]	[0.0025]	[0.0033]
plural birth	0.0760**	0.0733**	0.0177**	0.0139**
	[0.0015]	[0.0019]	[0.0010]	[0.0013]
Black	-0.0181**	-0.0188**	-0.0103**	-0.0066
	[0.0040]	[0.0052]	[0.0028]	[0.0036]
hispanic	-0.0024	0.0062	-0.0231**	-0.0182**
	[0.0039]	[0.0050]	[0.0028]	[0.0035]
Other	0.0250**	0.0288**	-0.0157**	-0.0092
	[0.0066]	[0.0082]	[0.0047]	[0.0057]
Fixed Effects	State	County	State	County
Observations	172,595	102,098	172,485	102,044
R-squared	0.06	0.07	0.03	0.04

Notes: Results displayed are from two linear probability models of the form of Eqn 1. The time period is limited to three months before (“pre”) and three months after (“post”) Lydon-Rochelle et al (2001). Standard errors are in brackets. * and ** indicate significance at the 5% and 1% levels respectively.

Table 4. Placebo and Falsification Tests

	Placebo #1: Feb 2001	Placebo #3: July 2000	Placebo #2: Oct 2000	Falsification Test #1: Prior birth but no prior C-section	Falsification Test #2: First-time Mothers
Outcome: Vaginal Birth					
post	-0.0428** [0.0164]	-0.0221 [0.0172]	-0.0253 [0.0167]	-0.0115* [0.0048]	0.0000 [0.0000]
post · HS degree	0.0032 [0.0082]	-0.0176* [0.0085]	0.0030 [0.0083]	0.0017 [0.0024]	0.0023 [0.0044]
post · some college	0.0089 [0.0090]	-0.0096 [0.0094]	-0.0056 [0.0091]	0.0008 [0.0027]	0.0045 [0.0050]
post · college degree	0.0046 [0.0101]	-0.0108 [0.0105]	-0.0037 [0.0102]	0.0019 [0.0031]	0.0051 [0.0056]
post · graduate school	0.0036 [0.0113]	-0.0192 [0.0117]	-0.0017 [0.0115]	0.0017 [0.0035]	0.0031 [0.0061]
post · age	0.0006 [0.0005]	0.0010 [0.0005]	0.0002 [0.0005]	0.0002 [0.0002]	-0.0003 [0.0003]
N	95,811	96,327	95,332	450,224	370,489
Outcome: Induced Labor					
post	-0.0005 [0.0118]	-0.0188 [0.0124]	-0.0126 [0.0120]	0.0094 [0.0074]	0.0196** [0.0070]
post · HS degree	-0.0069 [0.0059]	0.0053 [0.0062]	0.0065 [0.0060]	-0.0028 [0.0037]	-0.0072 [0.0043]
post · some college	0.0008 [0.0065]	0.0079 [0.0068]	-0.0014 [0.0066]	-0.0004 [0.0042]	-0.0031 [0.0049]
post · college degree	-0.0106 [0.0073]	0.0094 [0.0076]	0.0060 [0.0074]	-0.0009 [0.0048]	-0.0018 [0.0055]
post · graduate school	-0.0095 [0.0081]	0.0016 [0.0084]	0.0079 [0.0083]	0.0061 [0.0054]	-0.0031 [0.0060]
post · age	-0.0001 [0.0004]	0.0002 [0.0004]	-0.0003 [0.0004]	-0.0004 [0.0003]	-0.0004 [0.0003]
N	95,759	96,250	95,267	450,024	370,338

Notes: Standard errors in brackets. * significant at 5%; ** significant at 1%. The placebos are the three months before and after the indicated months and are limited to women with a previous C-section. Each regression includes the same set of additional controls as Table 3 along with county fixed effects.

Table 5. Response of VBAC and Induced Labor rates using Multiple Leads and Lags.

	VBAC		Induced Labor	
college · period(t-4)	0.0099*	0.0095	0.0055	0.0040
	[0.0049]	[0.0062]	[0.0035]	[0.0043]
college · period(t-3)	0.0034	0.0068	0.0095**	0.0073
	[0.0050]	[0.0062]	[0.0035]	[0.0043]
college · period(t-2)	0.0031	-0.0017	0.0056	0.0029
	[0.0050]	[0.0062]	[0.0035]	[0.0043]
college · period(t+1)	-0.0120*	-0.0166**	-0.0083*	-0.0114**
	[0.0048]	[0.0060]	[0.0034]	[0.0042]
college · period(t+2)	-0.0064	-0.0122	-0.0100**	-0.0144**
	[0.0050]	[0.0062]	[0.0035]	[0.0043]
college · period(t+3)	-0.0119*	-0.0120	-0.0115**	-0.0119**
	[0.0050]	[0.0063]	[0.0035]	[0.0044]
college · period(t+4)	-0.0030	-0.0042	-0.0071*	-0.0091*
	[0.0049]	[0.0062]	[0.0035]	[0.0043]
period(t-4)	0.0617**	0.0747**	0.0108	0.0114
	[0.0125]	[0.0167]	[0.0089]	[0.0116]
period(t-3)	0.0427**	0.0610**	0.0071	0.0016
	[0.0127]	[0.0168]	[0.0089]	[0.0117]
period(t-2)	0.0220	0.0276	0.0005	-0.0035
	[0.0127]	[0.0168]	[0.0090]	[0.0116]
period(t+1)	-0.0474**	-0.0527**	-0.0207*	-0.0301**
	[0.0124]	[0.0164]	[0.0088]	[0.0114]
period(t+2)	-0.0501**	-0.0469**	-0.0291**	-0.0363**
	[0.0126]	[0.0168]	[0.0089]	[0.0116]
period(t+3)	-0.0697**	-0.0541**	-0.0244**	-0.0321**
	[0.0131]	[0.0174]	[0.0092]	[0.0121]
period(t+4)	-0.0752**	-0.0762**	-0.0402**	-0.0520**
	[0.0129]	[0.0172]	[0.0091]	[0.0119]
Fixed Effects	State	County	State	County
Observations	494,042	302,036	493,706	301,858
R-squared	0.06	0.07	0.03	0.04

Notes: Each period consists of three consecutive months. The omitted group is the set of three months immediately before July 2001. Each regression includes the same set of additional controls as Table 3.