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COMPARATIVE EFFECTIVENESS IN MEDICINE: ANALYSIS OF EPISIOTOMY PRACTICE PATTERNS

by

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13. ABSTRACT (maximum 200 words)

This thesis provides empirical evidence to demonstrate or disprove claims that findings from a major systematic review published in 2005, have led to further declines in practices of episiotomy. The study uses data from the Healthcare Cost and Utilization Project: State Inpatient Databases (HCUP SID) and American Hospital Association (AHA) annual surveys. The sample consists of 648,141 patients from 897 hospitals between 2003 and 2008. Both fixed and random effects models are specified to estimate the effects of the JAMA publication, hospital characteristics including interaction terms and patient compositions on episiotomy rates. In addition the study analyzes variation of practice patterns to examine whether the JAMA publication has the desirable impact on clinical practices.

The results show that the declining episiotomy trends accelerate marginally after the JAMA publication. Hospitals do not also appear to respond differentially to the JAMA publication for most hospital characteristics, except for hospital sizes, maternity ward turnover and ownership structure. The analysis of practice pattern variation suggests that practice variations by volumes are declining but variances of episiotomy rates remain substantial. More effective strategies should be formulated to reach out to different audiences to bridge the gap between research evidences and clinical practices on episiotomy.

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COMPARATIVE EFFECTIVENESS IN MEDICINE: ANALYSIS OF EPISIOTOMY PRACTICE PATTERNS

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LIST OF ACRONYMS AND ABBREVIATIONS

ACOG	American Congress of Obstetricians and Gynecologists
AHA	American Hospital Association
AHRQ	Agency for Healthcare Research and Quality
AZ	Arizona
CA	California
FL	Florida
HCUP SID	Healthcare Cost and Utilization Project: State Inpatient Databases
ICD-9-CM	International Classification of Diseases, Clinical Modification, 9th revision
JAMA	Journal of American Medical Association
MA	Massachusetts
MD	Maryland
NHDS	National Hospital Discharge Survey
NJ	New Jersey
NY	New York
WA	Washington

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I. INTRODUCTION

A. BACKGROUND

Healthcare expenditures in the United States have been steadily rising to $2.5 trillion in 2009, which accounts for about 18% of gross domestic product.[1] In an interview with the New York Times, President Barack Obama highlighted the importance of using comparative effectiveness research as a way to reduce healthcare costs in the United States.[2] Comparative effectiveness studies aim to inform practitioners and patients about both the clinical and cost effectiveness of different treatment options for the same medical conditions. However, the true value of any comparative effectiveness research lies in its impact on practice patterns following these publications. It is therefore important to evaluate the benefits of these studies.

While there is a wide range of medical technology that can potentially benefit from comparative effectiveness research, this thesis focuses on one procedure, episiotomy, a surgical procedure commonly performed during deliveries of babies. Clinically, episiotomy is "a surgical procedure for widening the outlet of the birth canal to facilitate delivery of the baby and to avoid a jagged rip of the perineum (the area between the anus and the vulva, the opening to the vagina)."[3] The justifications for performing this procedure during deliveries are that episiotomy "facilitates delivery, spares the baby's head from trauma and prevents perineal lacerations and undue stretching of the pelvic floor."[4] In 2005, a major systematic review on the outcomes of

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[1] Centers for Medicare and Medicaid Services, U.S. Department of Health and Human Services, Table 1 - National Health Expenditures Aggregate, Per Capita Amounts, Percent Distribution, and Average Annual Percent Growth, by Source of Funds: Selected Calendar Years 1960–2009. http://www.cms.gov/NationalHealthExpendData/downloads/tables.pdf (accessed July 7, 2011).

[2] David Leonhardt, "After the Great Recession," *New York Times*, April 28, 2009. http://www.nytimes.com/2009/05/03/magazine/03Obama-t.html?_r=1&hp=&pagewanted=all (accessed July 7, 2011).

[3] Medicinenet.com, "MedTerms Dictionary." http://www.medterms.com/script/main/hp.asp (accessed July 7, 2011).

[4] R. F. Harrison, M. Brennan, P. M. North, J. V. Reed, and E. A. Wickham, "Is routine episiotomy necessary?" *British Medical Journal* 288 (1984): 1971.

routine episiotomy conducted by Hartmann, Visawanathan, Palmieri, Gartlehner, Thorp, and Lohr was published in the Journal of American Medical Association (JAMA), using collective data and evidences gathered from 1950 to 2004. Hartmann et al. found that in individual randomized clinical trials from the mid 1980s episiotomy was "associated with higher risk of anal sphincter and rectal injuries and precluded a woman from giving birth with an intact or minimally damaged perineum."[5] Hartmann et al.'s study concluded that evidence did not support any maternal benefits traditionally attributed to routine episiotomy. This study received wide media attention from the general media when the results were released, and could potentially inform wider audiences (i.e., pregnant women) than the smaller scale studies previously released mostly to clinicians.

Episiotomy is one of the most frequent operative procedures performed on women in the United States, but has been declining over the years.[6] In 2009, Frankman, Wang, Bunker, and Lowder studied trends of episiotomy use in the United States following recommendations from previous studies that discouraged routine episiotomy, using data collected at the national level from 1979 to 2004. The study also concluded that "routine episiotomy has declined since liberal usage has been discouraged."[7] Most of the other published articles reviewed and described the trends of episiotomy use in the United States based on shorter time periods or smaller population sizes.

Following publication of Hartmann et al.'s study, the American Congress of Obstetricians and Gynecologists (ACOG) released a practice bulletin in 2006 that encouraged practitioners to exercise clinical judgment to decide when episiotomy would be needed.[8] In 2009, at the ACOG 57th Annual Clinical Meeting, Johnson, Assistant

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5 Katherine Hartmann, Meera Viswanathan, Rachel Palmieri, Gerald Gartlehner, John Thorp, Jr, and Kathleen N. Lohr, "Outcomes of Routine Episiotomy: A Systematic Review," *The Journal of the American Medical Association* 293, no. 17 (2005): 2141.

6 Centers for Disease Control and Prevention, National Center for Health Statistics, "Hospital procedures, all-listed: US, 1990–2007," (n.d.). http://205.207.175.93/HDI/TableViewer/tableView.aspx?ReportId=605 (accessed July 12, 2011).

7 Elizabeth A. Frankman, Li Wang, Clareann H Bunker, and Jerry L. Lowder, "Episiotomy in the United States: has anything changed?" *American Journal of Obstetrics & Gynecology* (2009): 573.e1.

8 The American Congress of Obstetricians and Gynecologists, "ACOG News Release: ACOG Recommends Restricted Use of Episiotomies," March 31, 2006. http://www.acog.org/from_home/publications/press_releases/nr03-31-06-2.cfm (accessed July 12, 2011).

Professor at Brigham and Women's Hospital, commented that "clearly, the [Hartmann] article in JAMA in 2005 also had an effect. Everyone dropped to the same range."[9] However, there has been limited research to examine if practices of episiotomy decline following findings from Hartmann et al.'s study. This thesis aims to fill the gap in the literature and inform the medical community.

B. OBJECTIVES

The key objective of this thesis is to provide empirical evidence to demonstrate or disprove claims that findings from Hartmann et al.'s study have led to further declines in practices of episiotomy. In addition, this thesis will study the trend in episiotomy rates for the civilian population. Specifically, the primary research questions addressed in this thesis are:

(1) Does Hartmann et al.'s study have any effect on episiotomy rates and practice variation?

(2) How does the study's effect, if any, on episiotomy rates vary across hospital types and patients?

C. ORGANIZATION OF THESIS

The remainder of the thesis will proceed as follows. Chapter II discusses the existing literature on episiotomy pertaining to topics in this thesis. Chapter III presents the data and methodology of the research. Chapter IV provides descriptive statistics of the sample population data. Chapter V presents results of the multivariate analysis and Chapter VI provides the conclusions and discussions of this study.

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[9] Richard Hyer, "ACOG 2009: Steep Decline in Episiotomy Rates Credited to Research, Peer Pressure," *Medscape Medical News*, May 8, 2009. http://www.medscape.com/viewarticle/702541 (accessed July 12, 2011).

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II. LITERATURE REVIEW

This chapter starts by describing a brief historical overview of episiotomy. It proceeds to review existing literatures, which can be categorized into three broad groups: (1) clinical trials that examined the effectiveness of episiotomy and its policy of use, (2) meta-analyses that synthesized collective evidences and data from a selection of clinical trials, and (3) trend analyses that studied the overall episiotomy rates in the United States. This chapter also discusses factors attributed to variations in the practice of episiotomy. Finally, it concludes with a section highlighting the contribution to current discussion afforded by existing literature.

A. HISTORICAL OVERVIEW OF EPISIOTOMY

Several publications contain materials that are useful to this section. This section draws heavily from materials presented in "Benefits and Risks of Episiotomy: An Interpretative Review of the English Literature, 1860–1980."[10]

Episiotomy was first described in 1742 by Ould as "an incision made towards the anus with a pair crooked probe-sizar; introducing one blade between the head and vagina, as far as shall be thought necessary for the present purpose."[11] He also discussed the benefits and risks of episiotomy, and advised the use of such operative measures only when necessary. At the same time, he acknowledged that the safe delivery of a child would far more compensate for the damages done to the mother.[12] It was not until the nineteenth century that episiotomy was introduced by Taliaferro into the United States.

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[10] Stephen B. Thacker and H. David Banta, "Benefits and Risks of Episiotomy: An Interpretative Review of the English Language Literature, 1860–1980," *Obstetrical and Gynecological Survey* 38(6) (1983): 322–338.

[11] Fielding Ould, *A Treatise of Midwifery in Three Parts* (Dublin, Ireland: Nelson & Connor, 1742), 145–146. http://books.google.com/ebooks/reader?id=FCJzSBKbpPMC&printsec=frontcover&output=reader&pg=GBS.PA145 (accessed July 15, 2011).

[12] Ibid., 142. http://books.google.com/ebooks/reader?id=FCJzSBKbpPMC&printsec=frontcover&output=reader&pg=GBS.PA142 (accessed July 15, 2011).

Episiotomy was not widely practiced until the 20th Century. Well-known physicians such as Stahl and Hirst began advocating the use of episiotomy.[13] In 1920, at a meeting of the American Gynecological Society in Chicago, DeLee strongly advocated for a wider adoption of mediolateral episiotomy by practitioners for all deliveries. He argued that "we cannot do anything directly to save the pericervical connective tissues from radial and longitudinal overstretching and tears"[14] and explained that "we can take direct action to save the fascial and muscular structures of the pelvic floor."[15] In a time where "labor has been called, and still is believed by many to be, a normal function"[16], it is of no surprise that his publication met with severe criticisms at the meeting. However, his publication seeded a change in opinions of birth and episiotomy within the medical community.

Greater survivability of patients and improvement to the hygiene conditions began to shift societal views of delivery in hospitals. Thacker and Banta cited the prevention of puerperal fever as a critical influence that brought births from home into the hospital.[17] The proportion of women delivering in the hospitals rose steadily from less than 5% in 1900 to about 25% in 1930 before reaching above 80% by 1950.[18] As the number of deliveries increased, the practice of episiotomy also began to grow. Many obstetricians and midwives eventually accepted and considered episiotomy to be "the standard of care."[19] By 1979, episiotomy was performed in approximately 63% of all vaginal deliveries in the United States.[20]

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[13] Stephen B. Thacker and H. David Banta, "Benefits and Risks of Episiotomy," 324.

[14] Joseph B. DeLee, "*The prophylactic forceps operation" in Transactions of the American Gynecological Society: Volume 45 – For the year 1920,* ed. Ward GG, (Philadelphia, PA: WM. J. Dornan, 1920), 70. http://books.google.com/ebooks/reader?id=PLEDAAAAYAAJ&printsec=frontcover&output=reader&pg=GBS.PA70 (accessed July 15, 2011).

[15] Ibid.

[16] Ibid., 71.

[17] Stephen B. Thacker and H. David Banta, "Benefits and Risks of Episiotomy," 324.

[18] Ibid.

[19] Justin R. Lappen and Dana R. Gossett, "Changes in episiotomy practice: evidence-based medicine in action," *Expert Reviews Obstetrics & Gynecology* 5(3) (2010): 301.

[20] Stephen B. Thacker and H. David Banta, "Benefits and Risks of Episiotomy," 325.

B. CLINICAL TRIALS, META ANALYSES AND TREND ANALYSES

1. Selected Clinical Trials (1984–2004)

From 1919, numerous randomized controlled trials had been conducted to determine the effectiveness of routine episiotomy.[21] Most of these clinical researches had used extents of perineal injury, levels of postpartum (or post delivery) pain or discomfort, and rates of urinary and rectal continence to compare the benefits and risks between routine and restrictive policy of use of episiotomy. For the purpose of this research, we have selected and reviewed some of the trials that were mentioned in the 2005 JAMA article.

In 1984, at the Royal Berkshire Hospital in Reading, England, Sleep, Grant, Garcia, Elbourne, Spencer, and Chalmers conducted a clinical trial on 1,000 women who were randomly assigned to two different perineal management policies: (1) liberal (or routine) use of episiotomy, or (2) restrictive use of episiotomy. All 1,000 women had spontaneous vaginal deliveries and were delivered by midwives with similar level of experiences and skills. All episiotomies performed in the trial were mediolateral. The trial concluded that there was no significant difference in the levels of pain and discomfort experienced by the mothers in the three months following delivery. Sleep et al. also observed that "the overall rate of severe maternal trauma was much lower than expected from other published studies" and "the only difference observed was a tendency for women allocated to the restrictive episiotomy policy to resume sexual intercourse sooner."[22] In short, Sleep et al. found no evidence to support the practice of routine episiotomy. In 1987, Sleep and Grant followed up with the original 1,000 women by sending a questionnaire. Approximately 67% responded and the results were analyzed. Sleep and Grant found no significant differences in the rate of dyspareunia (painful

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[21] Ibid., 326.

[22] Jennifer Sleep, Adrian Grant, Jo Garcia, Diana Elbourne, John Spencer, and Iain Chalmers, "West Berkshire perineal management trial," *British Medical Journal* 289 (1984): 589.

sexual intercourse, due to medical or psychological causes) and urinary incontinence between the two groups.[23]

Between 1988 and 1990, at three university hospitals in Montreal, Canada, Klein, Gauthier, Jorgensen, Robbins, Kaczorowski, Johnson, Corriveau, Westreich, Waghorn, Gelf, Guralnick, Luskey, and Joshi enrolled 703 women, both primiparous (first-time mothers) and multiparous (mothers with prior birth experience(s)) in a trial to compare the effectiveness between routine and restrictive uses of episiotomy in preventing perineal trauma and deterioration of the pelvic floor muscular functions. The team found that there were no significant differences between routine and restrictive use of episiotomy in preventing perineal injuries or pelvic floor relaxation. The results also showed that "virtually all severe perineal trauma was associated with median episiotomy" and restrictive episiotomy performed on multiparous women would result in "significantly more intact perineum and less perineal suturing."[24]

Between 1990 and 1992, the Argentine Episiotomy Trial Collaborative Group conducted a randomized controlled trial in eight public hospitals in Argentina with 2,606 women, which consisted of both primiparous and multiparous. This was also the largest comparative effectiveness study related to the alternate policies of the use of episiotomy. Similar to the West Berkshire trials, the primiparous and multiparous groups were randomly assigned either routine episiotomy or restrictive episiotomy. All episiotomies performed were also mediolateral. The study concluded that "there is, then, no reliable evidence that routine use of episiotomy has any beneficial effect, and there is clear evidence that it may cause harm."[25] It also recommended that hospitals should adopt a restrictive episiotomy policy and keep episiotomy rates below 30%.

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[23] Jennifer Sleep and Adrian Grant, "West Berkshire perineal management trial: three year follow up," *British Medical Journal* 295 (1987): 751.

[24] Michael C. Klein, Robert J. Gauthier, Sally H. Jorgensen, James M. Robbins, Janusz Kaczorowski, Barbara Johnson, Marjolaine Corriveau, Ruta Westreich, Kathy Waghorn, Morrie M. Gelf, Melvin S. Guralnick, Gary W. Luskey, and Arvind K. Joshi, "Does Episiotomy Prevent Perineal Trauma and Pelvic Floor Relaxation?" *Obstetrical and Gynecological Survey* 49(4) (1994): 238. http://journals.lww.com/obgynsurvey/Citation/1994/04000/Does_Episiotomy_Prevent_Perineal_Trauma_and_Pelvic.8.aspx (accessed July 16, 2011).

[25] Argentine Episiotomy Trial Collaborative Group, "Routine vs selective episiotomy: A randomized controlled trial," *Lancet* 342(8886/8887) (1993): 1517–1518.

Between 2001 and 2002, in the city of Trieste, Italy, Sartore, De Seta, Maso, Pregazzi, Grimaldi, and Guaschino enrolled 519 primiparous women to study pelvic floor functions three months after delivery. The participants were grouped into two groups: (1) those who received mediolateral episiotomy, and (2) those with intact perineum (no lacerations) and spontaneous perineal lacerations (first- and second- degree). The participants were interviewed and put through a series of clinical examinations to determine their pelvic floor function and strength. The study concluded that "mediolateral episiotomy does not protect against urinary and anal incontinence and genital prolapsed and is associated with a lower pelvic floor muscle strength compared with spontaneous perineal lacerations and with more dyspareunia and perineal pain."[26]

While the setting and objectives of each of the above studies may differ, the researchers drew similar conclusions about the ineffectiveness of routine episiotomy in preventing perineal trauma, urinary continence and pelvic floor relaxation. In some cases, routine episiotomy was found to cause more harm than restrictive policy or spontaneous vaginal delivery without episiotomy. Although Klein et al. suggested that median episiotomy might cause several perineal injuries, none of the publications previously referenced compare directly the effectiveness between median and mediolateral episiotomies. It is also interesting to note that only Sleep et al. provided a rough monetary estimate of £65,000 (pounds in 1984) worth of suture materials in annual cost savings.[27] The Argentine Episiotomy Trial Collaborative Group also provided an estimated avoidance of approximately 90,000 surgical perineal repairs annually in Argentina if restrictive policy on the use of episiotomy was adopted from 1993.[28] More research can be conducted to determine the cost effectiveness of adopting a more restrictive use of episiotomy.

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[26] Andrea Sartore, Francesco De Seta, Gianpaolo Maso, Roberto Pregazzi, Eva Grimaldi, and Secondo Guaschino, "The Effects of Mediolateral Episiotomy," *Obstetrics & Gynecology* 103(4) (2004): 673. http://journals.lww.com/greenjournal/Fulltext/2004/04000/The_Effects_of_Mediolateral_Episiotomy_on_Pelvic.11.aspx (accessed July 16, 2011).

[27] Jennifer Sleep and Adrian Grant, "West Berkshire perineal management trial," 751.

[28] Argentine Episiotomy Trial Collaborative Group, "Routine vs Selective Episiotomy," 1518.

2. Selected Meta-Analysis (1983–2005)

Meta-analysis is defined as "a systematic method of evaluating statistical data based on results of several independent studies of the same problem."[29] For the purpose of this thesis, two meta analyses that would be useful for discussion have been selected and reviewed.

The aforementioned study by Thacker and Banta reviewed over 350 books and articles, published in English, from 1860 to 1980. They compiled data from these publications and analyzed them based on three identified benefits of episiotomy, namely: (1) prevention of third-degree lacerations, (2) prevention of serious damage to pelvic wall, and (3) prevention of trauma to the fetal head. Thacker and Banta found little evidence to suggest effectiveness of episiotomy in preventing perineal lacerations. Due to the lack of adequate data in the earlier studies, Thacker and Banta were not able to conclude if episiotomy was effective in preventing serious pelvic relaxation. On the same note, they found no evidence of benefits of episiotomy in preventing damages to newborns. Overall, they concluded that "Certainly, protecting the infant brain and the maternal perineum is important… This probable benefit, however, does not necessarily mean that more routine episiotomy can be justified."[30] They also highlighted risks of episiotomy including increased blood loss and higher intensity of pain after delivery and when resuming sexual intercourse after delivery. Following its publication, numerous randomized controlled trials were conducted to provide evidence on the ineffectiveness of routine episiotomy in preventing the risks highlighted in the study.

In 2005, Hartmann et al. conducted a comprehensive search on articles published in English, which were related to episiotomy and found that there were 986. Of the 986 articles, the team determined that only 26 of them met their inclusion criteria.[31] Hartmann et al. then dissected, grouped and analyzed the 26 studies based on three main categories, namely: (1) maternal postpartum outcomes that include perineal trauma, pain

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[29] *Mosby's Medical Dictionary*, 8th edition, "Meta analysis." http://medical-dictionary.thefreedictionary.com/Meta+analysis (accessed July 16, 2011).

[30] Stephen B. Thacker and H. David Banta, "Benefits and Risks of Episiotomy," 330-331.

[31] Katherine Hartmann et al., "Outcomes of Routine Episiotomy," 2142.

and healing, (2) pelvic muscle function outcomes that include urinary incontinence, fecal incontinence and pelvic floor defects, and (3) sexual function outcomes. With regard to short-term outcomes, they found fair to good evidence from the selected studies that showed women who had routine episiotomy were more likely to suffer from third- and fourth-degree lacerations and less likely to have intact perineum than those who were on restrictive use of episiotomy. At the same time, routine episiotomy was also less likely to reduce the intensity of pain. Hartmann et al. found that there were "no benefits from episiotomy" and "routine use is harmful to the degree that some proportion of women who would have had lesser injury instead had a surgical incision."[32] With regard to long-term outcomes, they found poor to fair evidence that showed a lack of benefits when adopting routine use of episiotomy. They also found that "those who have an episiotomy may be more likely to have pain with intercourse in the months after the pregnancy and are slower to resume having intercourse."[33] Hartmann et al. concluded that "in the absence of benefit and with a potential for harm, a procedure should be abandoned… In this instance, clinicians have been the primary agents to exercise choice to conduct or not conduct and episiotomy, rather than the patients."[34] In addition, the authors advocated that "rates of episiotomy of less than 15% of spontaneous vaginal births should be immediately within reach."[35]

Both meta analyses adopted similar approaches to identify benefits and risks of the practice of episiotomy. Thacker and Banta produced a comprehensive review of collective evidence and data from 1860 to 1980 and critically identified areas of research that were lacking. The article laid the foundation for better quality research related to episiotomy and was cited by over 270 articles.[36] Hartmann et al. meticulously reviewed more articles than any other meta analyses related to episiotomy and selected excellent

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[32] Ibid., 2147.

[33] Ibid.

[34] Ibid.

[35] Ibid.

[36] The citation count was based on Google Scholar, accessed July 17, 2011.

quality articles for analysis. Consistent with other meta analyses[37], Hartmann's study concluded that evidence did not support any maternal benefits traditionally attributed to routine episiotomy. In 2009, at the ACOG 57th Annual Clinical Meeting, Johnson presented her findings and concluded that "local peer pressure and response to significant research, in particular the Hartmann study, contributed to the substantial reduction in rates of episiotomy across patient and provider groups over the 10-year period." Her study was based on different population groups at Brigham and Women's Hospital in Boston, Massachusetts.[38] Following the publication of Hartmann et al.'s study, the ACOG released a practice bulletin in 2006 that encouraged practitioners to exercise clinical judgment to decide when episiotomy would be needed.[39]

3. Selected Trend Analyses (2005–2009)

Trend analyses are informative in nature and typically describe episiotomy rates in a certain geographical region over an extended time period. Some of these studies are timed and designed to describe impacts of significant recommended changes in clinical practices. In this section, we have selected and reviewed two non-overlapping studies.

In 2005, Graham, Carroli, Davies, and Medves conducted a study to examine episiotomy rates around the World between 1995 and 2004, following publication of clinical practice guidelines that discouraged the use of routine episiotomy. The team collected data from government websites, internet and published data in researches. A total of 42 countries in nine regions were analyzed. They found "an overall high rate of episiotomy with a decreasing trend in some countries, but also considerable variation in the use of the operation by country, within countries, and even within the same

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[37] Of the other meta analyses, there is a series of reviews that is regularly revisited by the Cochrane Collaboration. G. Carroli and L Mignini "Episiotomy for Vaginal Birth," *Cochrane Database of Systematic Reviews 2009* (1) (2009), Art. No.: CD000081. DOI: 10.1002/14651858.CD000081.pub2. http://www2.cochrane.org/reviews/en/ab000081.html (accessed July 17, 2011).

[38] Richard Hyer, "ACOG 2009: Steep Decline in Episiotomy Rates."

[39] The American Congress of Obstetricians and Gynecologists, "ACOG News Release: ACOG Recommends Restricted Use of Episiotomies."

professional provider group."[40] Graham et al. concluded that more efforts would be required to reduce the use of episiotomy around the world, especially in the developing countries.[41]

In 2009, Frankman et al. conducted a study to examine trends of episiotomy in the United States from 1979 to 2004, following recommendations made by the Cochrane Database of Systematic Reviews in 1999. The team extracted data from the National Hospital Discharge Survey (NHDS), using International Classification of Diseases, Clinical Modification, 9th revision (ICD-9-CM) diagnosis and procedure codes. They categorized the data into three different groups: (1) spontaneous vaginal deliveries, (2) operative (forceps- and vacuum-assisted) vaginal deliveries, and (3) cesarean deliveries.[42] They found that episiotomy rates with all vaginal deliveries had dropped significantly from approximately 61% in 1979 to approximately 25% in 2004 and attributed this decline to past researches, which provided evidence on the risks of routine episiotomy. They also found that "anal sphincter lacerations rates with spontaneous vaginal delivery have decreased, likely reflecting the decreased usage of episiotomy."[43] Their results also showed that "the decline in operative vaginal delivery corresponds to a sharp increase in cesarean delivery, which may indicate that practitioners are favoring cesarean delivery for difficult births."[44]

Although there are several other trend analyses that were published, most of the other trend analyses either use a subset of population data or use a truncated period of the data used in the aforementioned studies by Graham et al. and Frankman et al.. However, there had been very few studies that examined the effect of Hartmann et al.'s study on episiotomy rates in the United States. The only trend analysis that was designed to do so was presented by Johnson at the ACOG 57th Annual Clinical Meeting. However, the

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[40] Ian D. Graham, Guillermo Carroli, Christine Davies, and Jennifer M Medves, "Episiotomy Rates Around the World: An Update," *BIRTH* 32(3) (2005): 220.

[41] Ibid., 219.

[42] Elizabeth A. Frankman et al., "Episiotomy in the United States," 573.e2.

[43] Ibid., 573.e1.

[44] Ibid.

population of interest was localized and may not be representative of the trends in the United States.

C. FACTORS ATTRIBUTED TO VARIATIONS IN PRACTICE OF EPISIOTOMY

Apart from comparative effectiveness research, several research studies also explored reasons for variations in practice of episiotomy, which include provider type, hospital type and temporal patterns. In this section, we have selected and reviewed three independent studies and an expert review by Lappen and Gosette in 2010.

In 2000, Robinson, Norwitz, Cohen, and Lieberman studied the factors influencing the practice of episiotomy at spontaneous vaginal delivery. The study population consisted of 1,576 records of consecutive primiparous with no diabetic conditions at Brigham & Women's Hospital between 1994 and 1995. The team concluded that "the factor most strongly associated with episiotomy was the category of obstetric care provider."[45] They found that private clinicians were four times more likely to use episiotomy than midwives and more than double, compared to faculty providers. The team also concluded that other factors such as length of second stage of labor, size of the baby[46] and use of epidural analgesia would result in increased episiotomy use.[47]

In 2004, Howden, Weber, and Meyn examined trends in episiotomy practice among residents, faculty and private clinicians at Magee-Womens Hospital from 1995 to 2000. The study population consisted of 27,702 women with 15,190 episiotomies. In the five-year period, the team observed a "persistently high rate of episiotomy use at deliveries attended by private practitioners at our institution."[48] This finding was

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[45] Julian N. Robinson, Errol R. Norwitz, Amy P. Cohen, and Ellice Lieberman, "Predictors of Episiotomy Use at First Spontaneous Vaginal Delivery," *Obstetrics & Gynecology* 96(2) (2000): 216. http://journals.lww.com/greenjournal/Abstract/2000/08000/Predictors_of_Episiotomy_Use_at_First_Spontaneous.11.aspx (accessed July 23, 2011).

[46] The study used birth weight of greater than 4kg as one of the predictor of episiotomy.

[47] Julian N. Robinson et al., "Predictors of Episiotomy Use," 217.

[48] Nancy L. S. Howden, Anne M. Webber, and Leslie A. Meyn, "Episiotomy Use among Residents and Faculty Compared with Private Practitioners,' *Obstetrics & Gynecology* 103(1) (2004): 116. http://www.acog.org/from_home/publications/green_journal/2004/v103n1p114.pdf (accessed July 23, 2011).

consistent with Robinson et al.'s study. The study concluded that private practitioners were seven-fold more likely than academic practitioners to perform episiotomy on their patients.[49]

In 2002, Webb and Culhane studied the time of day variation in use of episiotomy and operative delivery. The study was based on the Philadelphia Perinatal Database and the population data consisted of 37,332 delivery cases in more than 25 Philadelphia metropolitan area hospitals from 1994 to 1997.[50] They found that the temporal patterns for episiotomies and operative deliveries consistently swung from a low during the two-hour period at 2 am to a high during the two-hour period at 12 noon.[51] They posit that clinicians could be more inclined to perform operative procedures to expedite deliveries during the day when patient demands would be higher.[52]

In 2010, Lappen and Gosette produced a noteworthy literature review, which highlighted how practices in episiotomy had evolved. One important aspect that they discussed was the changes in attitudes among practitioners. They found that "new recommendations for restrictive use of episiotomy have not been universally accepted."[53] They also found that cultural differences among obstetric practitioners might be the key reason why obstetrics lagged behind other disciplines in efforts to put in place standardized practices. Citing selected research studies, Lappen and Gosette listed beliefs and views of practitioners, "lack of awareness or familiarity with current recommendations," "lack of self-efficacy to make practice changes" and "lack of outcome expectancy" as some of the reasons why obstetricians fail to follow guidelines.[54] They concluded that additional education of practitioners, especially private clinicians or

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[49] The results showed that the average rate of episiotomy use among academic clinicians was 17.7%, compared to 67.1% among private practitioners.

[50] David A. Webb and Jennifer F. Culhane, "Time of day variation in rates of obstetric intervention to assist in vaginal delivery," *J Epidemiol Community Health* 56 (2002): 577. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1732224/pdf/v056p00577.pdf (accessed July 23, 2011).

[51] Ibid.

[52] Ibid., 578.

[53] Justin R. Lappen and Dana R. Gossett, "Changes in episiotomy practice," 304.

[54] Ibid., 305.

more senior physicians, might lead to further declines in episiotomy rates and hence reduce complications related to episiotomy use.[55]

Among the factors discussed above, the most common, and perhaps the most important, finding is the effect of provider type on the rate of episiotomy. It is also worth noting that both Robinson et al. and Howden et al. conducted their studies in academic medical facilities. To quote Lappen and Gosette, "the fact that private physicians in practice at these (academic medical) centers were failing to adopt evidence-based delivery practices was concerning."[56] This suggests that hospital characteristics may also have an impact on the practice of episiotomy. Most of the other factors discussed are associated with unobservable characteristics of the environment and practitioners such as culture of the medical centers and motivation of the providers. This thesis aims to determine the effects of provider type and hospital characteristics on the use of episiotomy, within the limitations of the available datasets.

D. CONTRIBUTION TO THE CURRENT LITERATURE

Table 1 presents the list of studies reviewed in order of publication dates. Much of the existing literatures on episiotomy were conducted based on either a short time period or a localized population sample. Hartmann et al. produced an outstanding review based on high quality research data selected from a large pool of over 980 articles. Yet no study has documented to what extent clinicians really follow recommendations from such major study. In addition, none of the studies reviewed above have examined whether practice patterns and variations in the use of episiotomy differ by the hospital environment in which the physicians operated in.

Unlike Johnson's study that only described episiotomy rates based on different population groups in a small area[57], this thesis focuses on examining trends in episiotomy rates in eight different states in the United States, using data from (1) Agency for

[55] Ibid.

[56] Ibid.

[57] Richard Hyer, "ACOG 2009: Steep Decline in Episiotomy Rates."

Healthcare Research and Quality (AHRQ)[58], and (2) American Hospital Association (AHA) annual survey database and contribute to the existing literatures on episiotomy.

Table 1. List of studies reviewed, by publication dates

Year	Author(s)	Title	Description
1742	Ould	A Treatise of Midwifery in Three Parts	First described "episiotomy."
1920	DeLee	The Prophylactic Forceps Operation	Advocated for a wider adoption of mediolateral episiotomy.
1983	Thacker and Banta	Benefits and Risks of Episiotomy: An Interpretative Review of the English Literature, 1860–1980	Meta analysis: Reviewed over 350 books and articles from 1860 to 1980.
1984	Sleep et al.	West Berkshire Perineal Management Trial	Clinical trial: 1,000 participants in Royal Berkshire Hospital, England in 1982.
1987	Sleep and Grant	West Berkshire Perineal Management Trial: Three Year Follow Up	Clinical trial follow-up: 674 participants in 1987.
1993	Argentina Episiotomy Trial Collaborative Group	Routine vs. Selective Episiotomy: A Randomized Controlled Trial	Clinical trial: 2,606 participants in eight public hospitals in Argentina from 1990 to 1992.
1994	Klein et al.	Does Episiotomy Prevent Perineal Trauma and Pelvic Floor Relaxation?	Clinical trial: 703 participants in three hospitals in Montreal, Canada from 1988 to 1990.
2000	Robinson et al.	Predictors of Episiotomy Use at First Spontaneous Vaginal Delivery	Data analysis: 1,576 records in Brigham & Women's Hospital, United States from 1994 to 1995.
2002	Webb and Culhane	Time of Day Variation in Rates of Obstetric Intervention to Assist in Vaginal Delivery	Data analysis: 37,332 records in more than 25 hospitals in Philadelphia, United States from 1994 to 1997.
2004	Howden et al.	Episiotomy Use among Residents and Faculty Compared with Private Practitioners	Data analysis: 27,702 records in Magee-Womens Hospital, United States from 1995 to 2000.
2004	Sartore et al.	The Effects of Mediolateral Episiotomy	Clinical trial: 519 participants in Italy from 2001 to 2002.
2005	Hartmann et al.	Outcomes of Routine Episiotomy: A Systematic Review	Meta analysis Screened 986 articles from 1950 to 2004 and included 26 for analysis.
2005	Graham et al.	Episiotomy Rates Around the World	Trend analysis: Analyzed episiotomy rates in 42 countries in nine regions from 1995 to 2004.
2009	Carroli and Mignini	Episiotomy for Vaginal Birth	Meta analysis: Reviewed eight articles (5,541 participants).
2009	Frankman et al.	Episiotomy in the United States: Has Anything Changed?	Trend analysis: Examined episiotomy rates in the United States from 1979 to 2004.
2010	Lappen and Gossett	Changes in Episiotomy Practice: Evidence-based Medicine in Action	Literature review: Reviewed 63 articles from 1742 to 2009.

[58] The data is collected by the California Office of Statewide Health Planning and Development and provided to AHRQ.

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III. DATA AND METHODOLOGY

This chapter identifies sources of data and codes used to identify patient groups. It proceeds to set up a statistical model for hospital-level multivariate analyses exploring the effect of provider type and hospital type on use of episiotomy for civilian populations. It concludes with a section highlighting limitations of the study.

A. DATA SOURCES

This analysis uses several data sources. Healthcare Cost and Utilization Project: State Inpatient Databases (HCUP SID) and American Hospital Association (AHA) annual surveys are linked to create an analytical sample for the civilian population. The HCUP SID databases, which contain all hospital discharges from the following eight states, are used: Arizona, California, Florida, Massachusetts, Maryland, New Jersey, New York, and Washington. Together, the eight states represent 36% of the US female population in 2009.[59] The AHA annual survey database is used to supplement hospital characteristic data that are not found in the HCUP SID databases.

1. Healthcare Cost and Utilization Project: State Inpatient Database

The HCUP SID databases contain more than 100 different fields of clinical and demographic information from hospital discharge records from 44 participating states in the United States. These databases are compiled and maintained by the Agency for Healthcare Research and Quality (AHRQ).[60]

Data pertaining to spontaneous vaginal deliveries and operative vaginal deliveries between 2003 and 2008 are extracted from the databases, using International Classification of Diseases, Clinical Modification, 9th revision (ICD-9-CM) diagnosis and procedure codes. For the purpose of this thesis, clinical and demographic information

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[59] U.S. Census Bureau, "Table 3. Annual Estimates of the Resident Population by Sex, Race, and Hispanic Origin for the United States: April 1, 2000 to July 1, 2009 (NC-EST2009-03)," June 2010. http://www.census.gov/popest/national/asrh/NC-EST2009/NC-EST2009-03.xls (accessed July 31, 2011).

[60] Healthcare Cost and Utilization Project, "Overview of the State Inpatient Databases," June 16, 2011. www.hcup-us.ahrq.gov/sidoverview.jsp (accessed July 31, 2011).

including patients' age, race, payment sources, principal diagnose and up to five secondary diagnoses, procedures received (up to ten) and admitted hospital identifications are extracted. Observations with missing unique identifiers for hospital are dropped. Race information for patients from Washington State is missing between 2003 and 2007. To fill the missing information, these observations are assigned "unknown race." A total of 648,141 hospital discharge records from 897 hospitals are extracted and aggregated at the hospital level for each quarter between 2003 and 2008.

2. American Hospital Association Annual Survey

The AHA collects over 1,000 data items through annual online surveys from over 6,500 hospitals in the United States. The database contains information on hospital characteristics and operations such as hospitals' facilities and including available services, utilization, personnel and finances.[61]

To be consistent with the HCUP SID databases, data between 2003 and 2008 are extracted from the AHA databases. For the purpose of this study, the data fields extracted include hospital type, teaching hospital, obstetric care unit level, number of births and number of available bassinets. To merge the datasets, a balanced panel is created to store observations comprising two delivery types and four payment sources in 897 hospitals for a period of 24 quarters, to account for the fact that some hospitals might have zero number of deliveries in a given quarter. AHA and HCUP SID data are merged using a crosswalk between the two databases' unique hospital identifiers. The merged dataset contains 172,224 observations, representing 897 unique hospitals. Because AHA surveys are conducted on annual basis while HCUP SID data are extracted on quarterly basis, all four quarters from the same year of a given hospital would have the same AHA values.

[61] American Hospital Association, "Survey History and Methodology," (n.d.). http://www.ahadata.com/ahadata/html/historymethodology.html (accessed July 31, 2011).

B. IDENTIFYING PATIENT GROUPS

The ICD-9-CM is used to assign codes to diagnoses and procedures related to hospital utilization in the United States. It is widely used in medical records and most National Center for Health Statistics (NCHS) surveys. The ICD-9-CM is based on the World Health Organization's 9th revision, International Classification of Diseases. The NCHS and the Centers for Medicare and Medicaid Services are responsible for maintaining and updating the ICD-9-CM.[62]

For this thesis, we use ICD-9-CM diagnosis to identify two delivery types, namely: (1) spontaneous vaginal deliveries and (2) operative vaginal deliveries (forceps- and vacuum-assisted). To identify spontaneous vaginal deliveries, ICD-9-CM diagnosis code 650 is used. The population data consist of only singleton, full-term, live-born, cephalic[63] deliveries without fetal rotation and instrumentation such as forceps, vacuum or cesarean births. Multiple gestations, preterm deliveries (<37 weeks' gestational age) and breech deliveries are excluded. Maternal and fetal complications such as ectopic and molar pregnancy, prolonged labor, fetal abnormality, placenta problems and puerperium complications are also excluded.[64] For spontaneous vaginal deliveries with episiotomy, ICD-9-CM procedure code 73.6 is used to extract the data.[65]

To identify operative vaginal deliveries, ICD-9-CM diagnosis code 669.5 is used. Only deliveries by forceps and vacuum extractors without specified complications are

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62 Centers for Disease Control and Prevention, "International Classification of Diseases, Ninth Revision, Clinical Modification," June 21, 2011. http://www.cdc.gov/nchs/icd/icd9cm.htm (accessed on July 24, 2011).

63 Cephalic is defined as "pertaining to head." *Mosby's Medical Dictionary*, 8th edition, "Cephalic," (n.d.). http://medical-dictionary.thefreedictionary.com/Cephalic (accessed July 24, 2011).

64 ICD9.chrisendres.com, "650 Normal Delivery," (n.d.). http://icd9cm.chrisendres.com/index.php?srchtype=diseases&srchtext=650&Submit=Search&action=search (accessed July 24, 2011).

65 ICD9.chrisendres.com, "669.5 Forceps or vacuum extractor delivery without mention of indication," (n.d.). http://icd9cm.chrisendres.com/index.php?srchtype=diseases&srchtext=669.5&Submit=Search&action=search (accessed July 24, 2011).

included in the analysis.[66] For operative vaginal deliveries with episiotomy, ICD-9-CM procedure codes 72.1 (low or outlet forceps), 72.21 (mid forceps), 72.31 (high forceps) and 72.71 (vacuum extraction) are used to extract the data.[67]

C. STATISTICAL MODELS FOR HOSPITAL-LEVEL MULTIVARIATE ANALYSES OF PROVIDER TYPE AND HOSPITAL TYPE ON USE OF EPISIOTOMY (CIVILIAN POPULATION)

As discussed in the literature review earlier, provider type and hospital characteristics may influence acceptance rates among practitioners and consequently episiotomy rates following the publication of the JAMA article by Hartmann et al. in 2005. Hospital fixed-effects regression techniques are used to determine the effects of provider type and hospital characteristics on use of episiotomy across states. Figure 1 presents the general form of the econometric specifications.

$$epi\_rate_{it} = \sum_j \beta_j \times JAMA_t \times x_{ij} + \sum_k \beta_k \times w_{ikt} + \mu_i + \gamma_t + \varepsilon_{it}$$

where

1. $epi\_rate_{it} = \dfrac{number\ of\ episiotomy_{it}}{number\ of\ delivery\ type_{it}}$ or rate of episiotomy performed at hospital i at time t for spontaneous and operative deliveries,
2. Interaction Terms:
   a. $JAMA_t =$ 1 if after second quarter of 2005 $\left(\begin{array}{l}\text{i.e. after the publication of}\\ \text{Hartman et al. in May 4, 2005}\end{array}\right)$,
   b. $x_{ij} =$ a set of j time-invariant hospital characteristics,
3. $w_{ikt} =$ a set of k time-variant hospital characteristics,
4. $\mu_j =$ hospital – specific fixed effects,
5. $\gamma_t =$ a set of year and quarter fixed effects,
6. $\varepsilon_{it} =$ an i.i.d error term.

Figure 1. Baseline multivariate model specification

[66] ICD9.chrisendres.com, “73.6 Episiotomy,” (n.d.). http://icd9cm.chrisendres.com/index.php?srchtype=procs&srchtext=73.6&Submit=Search&action=search (accessed July 24, 2011).

[67] Ibid.

For the first part of the analysis, the least square fixed effects method is used to estimate these models. The dependent variables for each of the fixed effects models are specified as episiotomy rates (instead of the actual number of episiotomy performed), to account for potential heteroskedasticity resulting from high number of episiotomies associated with larger or high-volume hospitals. The key independent variables are the JAMA indicator and the interaction terms between the JAMA indicator and hospital variables. They are used to estimate the difference-in-differences effects. The regression model includes percentage of patients in each of the four age categories (18-24 [reference group], 25-29, 30-34 and 35 and above), five race categories (white [reference group], black, Hispanic, other races and unknown races), and three payment source groups (Medicaid [reference group], private insurance and other sources including self-pay and no charge) to control for the underlying differences in episiotomy rates due to the traits of each demographic characteristic.[68] Year and quarter dummy variables are included in the specifications to control for macro and seasonal trends of episiotomy rates between 2003 and 2008. The hospital-specific fixed effects account for any unobserved heterogeneity across hospitals that do not vary over time but may affect baseline episiotomy rates and any other unobserved dimensions, which could include the underlying quality of care, practice belief, and hospital's managerial differences. To account for unobserved cluster effects, robust standard errors that allow "cluster correlation" and heteroskedasticity within hospitals are applied.[69]

For the second part of the analysis, random effects regression technique is applied to estimate the models. Time-invariant hospital characteristics are included as explanatory variables in the model specifications. Even though the assumption that the unobserved effect is uncorrelated with all explanatory variables[70] may not hold true in this analysis, random effects estimation is still useful to investigate the effects of time-constant hospital characteristics on episiotomy rates.

[68] Elizabeth A. Frankman et al., "Episiotomy in the United States," 573.e2.

[69] Jeffery M. Wooldridge, *Introductory Econometrics: A Modern Approach, 4e Edition*, (Mason, OH: South-Western Cengage Learning, 2009), 495–496.

[70] Ibid., 489-491.

Provider type is one of the most important factors that might affect episiotomy rates.[71] However, these data are not readily available in the databases. To proxy for provider type, we use hospital ownership to capture possible differential reactions to the JAMA article. Physicians, who chose to practice in for-profit hospitals, might have different incentives from those in not-for-profit or government hospitals, due to different revenue sharing arrangements across hospital types. In general, physicians got additional reimbursement for performing episiotomies (according to Medicare, the average payment for an episiotomy alone is between $150 and $200[72]). Consequently, we might therefore expect physicians in for-profit hospitals to be less willing to abandon this procedure, compared to physicians in government or not-for-profit hospitals.

Teaching hospitals, defined as being members of the Council of Teaching Hospitals, are specified in the model. According to Lappen and Gosette[73], cultural differences in hospital systems are likely to produce different responses to medical research. According to Robinson et al.[74] and Howden et al.[75], private clinicians are more likely to perform episiotomies on their patients, compared to faculty practitioners. We use teaching and non-teaching hospitals as a proxy for cultural differences. We expect teaching hospitals to be more receptive and hence more likely to adopt recommendations from major publications like the JAMA article.

The effect of specialization in obstetric care on episiotomy rates is not discussed in any of the previous literatures. However, we postulate that the level of specialization is likely to affect work culture, and a more specialized hospital would respond like an academic medical center to comparative effectiveness studies. To study this effect, we include obstetric unit care level in our model specifications. The obstetric unit care levels

[71] Justin R. Lappen and Dana R. Gossett, "Changes in episiotomy practice," 304.

[72] The average payment is for episiotomy or vaginal repair, by other than attending facility and non-facility physicians, based on 2011 CPT codes and Medicare payment information. See American Medical Association, "cpt® Code/Relative Value Search,"(n.d.). https://ocm.ama-assn.org/OCM/CPTRelativeValueSearchResults.do?locality=1&keyword=episiotomy (accessed September 27, 2011).

[73] Justin R. Lappen and Dana R. Gossett, "Changes in episiotomy practice," 304.

[74] Julian N. Robinson et al., "Predictors of Episiotomy Use," 216.

[75] Nancy L. S. Howden et al., "Episiotomy Use Among Residents and Faculty," 116.

range from non-obstetric to obstetric unit care level three. Obstetric unit care level one refers to hospitals that "provide services for uncomplicated maternity and newborn cases"[76]. Hospitals with obstetric unit care level two "provide services for all uncomplicated maternity and most complicated cases"[77] and hospitals with obstetric level three "provide services for all serious illnesses and abnormalities"[78]. We hypothesize that hospitals that can handle more complicated obstetric cases are more likely to adopt recommendations from the JAMA article.

Patient demand is identified as one of the factors that may influence episiotomy rates. However, these data are not readily available in the databases. To proxy for patient demand, we include maternity ward turnover in the models. We define maternity ward turnover as individual hospitals' ratio of annual births to number of bassinets. We assume that a higher birth-to-bassinet ratio will imply higher patient demands. According to Webb and Culhane, practitioners are more inclined to perform episiotomy when patient demands are higher, as a way to facilitate the delivery.[79] We hypothesize that the JAMA article is less likely to lower episiotomy rates in hospitals with higher annual turnover rate.

D. LIMITATIONS OF STUDY

One possible limitation of this analysis is generalization of episiotomy trends in the eight selected states to that at the national level. To determine if the female population across the eight states is representative of the United States female population, we study the race and age composition of these two populations. Table 2 summarizes the race distribution at the state and national level using 2009 population estimates data from the U.S. Census Bureau. The overall female population in the eight states is approximately 36% of the national female population. In general the representation of

[76] American Hospital Association, "AHA Annual Survey Database - Fiscal Year 2009: Public File Layout and Code Descriptions," 2010. http://www.ahadata.com/ahadata/files/2011/as2009lay.pdf (accessed August 11, 2011).

[77] Ibid.

[78] Ibid.

[79] David A. Webb and Jennifer F. Culhane, "Time of day variation," 577.

the white and minority populations differ significantly across the eight states. Massachusetts has the highest proportion of white females while Maryland has the highest black female representation across the eight states. The overall white and black female representations in the eight states are below that at the national level by nine and two percentage points respectively. On the flip side, the overall Hispanic and other races representations are above that at the national level by eight and three percentage points respectively. Overall, the female population by ethnic groups in the eight states is only representative of states with similar ethnic distribution among the female population and not at the national level.

Table 2. Race distribution of female population by nation and states (AZ, CA, FL, MA, MD, NJ, NY, WA), 2009

	Overall Female Population	White		Black		Hispanic		Other Races	
		Pop.	%	Pop.	%	Pop.	%	Pop.	%
Arizona	3,288,937	1,917,316	58.3	118,693	3.6	974,552	29.6	278,376	8.5
California	18,456,462	7,761,860	42.1	1,123,430	6.1	6,644,865	36.0	2,926,307	15.9
Florida	9,414,043	5,634,270	59.8	1,451,680	15.4	1,954,790	20.8	373,303	4.0
Massachusetts	3,388,604	2,679,153	79.1	201,743	6.0	288,238	8.5	219,470	6.5
Maryland	2,935,672	1,656,377	56.4	879,834	30.0	193,307	6.6	206,154	7.0
New Jersey	4,439,395	2,730,993	61.5	600,438	13.5	709,840	16.0	398,124	9.0
New York	10,042,290	6,005,076	59.8	1,539,157	15.3	1,642,430	16.4	855,627	8.5
Washington	3,335,242	2,504,284	75.1	108,936	3.3	322,523	9.7	399,499	12.0
Sample Overall	55,300,645	30,889,329	55.9	6,023,911	10.9	12,730,545	23.0	5,656,860	10.2
National	155,557,060	101,670,507	65.4	19,714,798	12.7	23,362,405	15.0	10,809,350	6.9

Source: Generated using data from U.S. Census Bureau, Population Division, Annual Estimates of the Resident Population by Sex, Race, and Hispanic Origin for the United States, Arizona, California, Florida, Massachusetts, Maryland, New Jersey, New York and Washington: July 1, 2009, June 2010.

Table 3 summarizes the age distribution of the female population in the eight states and at the national level using the 2009 population estimates from the United States Census Bureau. In general, the female age distribution across each of the eight states is well representative of the United States female population. The majority of the population is in the 35 and over group while the rest of population is evenly distributed across the other three age groups.

Table 3. Age distribution of female population by nation and states (AZ, CA, FL, MA, MD, NJ, NY, WA), 2009

	Female Population (Above 17)	18 – 24		25 – 29		30 – 34		35 and above	
		Pop.	%	Pop.	%	Pop.	%	Pop.	%
Arizona	3,662,883	290,136	7.9	235,319	6.4	218,966	6.0	2,918,462	79.7
California	20,972,487	1,793,400	8.6	1,331,456	6.3	1,243,564	5.9	16,604,067	79.2
Florida	11,141,965	802,593	7.2	595,349	5.3	542,880	4.9	9,201,143	82.6
Massachusetts	4,089,637	334,575	8.2	216,562	5.3	208,118	5.1	3,330,382	81.4
Maryland	3,496,120	268,732	7.7	195,382	5.6	183,900	5.3	2,848,106	81.5
New Jersey	5,285,420	368,729	7.0	270,171	5.1	270,188	5.1	4,376,332	82.8
New York	11,947,883	950,106	8.0	676,045	5.7	641,219	5.4	9,680,513	81.0
Washington	3,919,145	307,352	7.8	243,181	6.2	218,462	5.6	3,150,150	80.4
Sample Overall	64,515,540	5,115,623	7.9	3,763,465	5.8	3,527,297	5.5	52,109,155	80.8
National	180,444,279	14,759,935	8.2	10,562,159	5.9	9,780,629	5.4	145,341,556	80.5

Source: Generated using data from U.S. Census Bureau, Population Division, Annual Estimates of the Resident Population by Sex and Selected Age Groups for the United States, Arizona, California, Florida, Massachusetts, Maryland, New Jersey, New York and Washington: July 1, 2009, June 2010.

A second possible limitation is the generalization of the hospital distribution across the eight states to that at the national level. Table 4 summarizes the annual statistics of civilian hospital characteristics between 2003 and 2008. Hospitals with less than 25 births are excluded. On average, there are over 3,750 hospitals in the United States, compared to 868 hospitals (i.e., approximately 23% of all hospitals in the United States) in all eight states. Despite the lower number of hospitals, the eight states combined deliver on average, more births per hospital annually (i.e., average of 1,945 births vs. average of 1,157 births), compared to the national level statistics. The number of bassinets per hospital in all eight states is also higher (i.e., average of 24 bassinets per hospital vs. average of 17 bassinets per hospital). The mean turnover rate of the bassinets at the hospitals in all eight states is therefore higher than that at the national level (i.e., average of 85 births per bassinet vs. average of 59 births per bassinet).

The distribution of hospital type is comparable between the two set of data. However, in the eight states, there are no federally funded government hospitals in the dataset. The eight states have higher proportion of not-for-profit hospitals (i.e., 72% vs. 62%) than that at the national level. The proportion of non-federally funded hospitals at the national level (i.e., 20% vs. 14%) is greater. A higher proportion of teaching hospitals are observed in the eight states (i.e., 14% vs. 7%). In terms of the level of obstetric care, the proportion of each level is comparable between the eight states and the national level. The main difference is that the eight states have a greater proportion of hospitals offering obstetric care level three (i.e., 20% vs. 14%).

In summary, the distribution of civilian hospital characteristics in the eight states does not well represent that at the national level. Results from the multivariate analysis should be applied to states with civilian hospital characteristics distribution close to that of the eight states.

Table 4. Descriptive statistics of civilian hospital characteristics, 2003–2008

	National		Eight States	
	Mean	**SD**	**Mean**	**SD**
Hospital Characteristics				
Births	1,157	(1,419.2)	1,945	(1,826.1)
Bassinets	17	(15.5)	24	(20.3)
Maternity ward turnover (births/bassinets)	59.0	(44.3)	84.5	(53.8)
Hospital Type				
For-profit (%)	16.3	(36.2)	13.7	(33.6)
Not-for-profit (%)	62.1	(47.7)	72.0	(44.2)
Government (non-Federal) (%)	19.7	(39.3)	14.3	(34.3)
Government (Federal) (%)	1.9	(13.6)	0.0	(0.0)
Overall (%)	100.0		100.0	
Teaching				
Teaching (%)	7.0	(25.1)	13.8	(33.7)
Non-teaching (%)	93.0	(25.1)	86.2	(33.7)
Overall (%)	100.0		100.0	
Obstetric Level				
Non-obstetric (%)	26.5	(36.9)	23.6	(34.0)
Obstetric Level 1 (%)	33.3	(41.7)	30.5	(40.4)
Obstetric Level 2 (%)	26.3	(39.9)	25.7	(39.3)
Obstetric Level 3 (%)	13.9	(31.1)	20.2	(36.7)
Overall (%)	100.0		100.0	
Number of Hospitals	3,754		868	

Source: Generated from data extracted from American Hospital Association, AHA Annual Survey Database: 2003, 2004, 2005, 2006, 2007, and 2008 (accessed October 28, 2011).

Another possible limitation is the use of hospital ownership to proxy for provider type. The HCUP SID and AHA databases do not provide sufficient resolution on provider type. Reimbursement sharing arrangements between hospitals and physicians are different across for-profit, not-for-profit and government hospitals. Hence, we postulate that hospital type is highly correlated to provider type (i.e., arrangements in for-profit hospitals tend to be profit-driven). It is therefore reasonable although not perfect to use hospital type to proxy for provider type.

One last possible limitation of this study stems from using maternity ward turnover as proxy for patient demand. The HCUP SID and AHA databases do not provide data on number of obstetric practitioners in each hospital. Hence, we rule out using doctor-to-patient ratio as a proxy for patient demand. We posit that the daily number of deliveries that a hospital can handle is limited to the number of available bassinets and that there are no substitutes for bassinets in hospitals. Therefore, it is reasonable to use maternity ward turnover as proxy for patient demand. However, the aggregated annual information might not be sensitive enough to capture the true effect of patient demand on episiotomy rates.

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IV. DESCRIPTIVE STATISTICS

This chapter presents summary statistics useful for providing context to the interpretation of episiotomy trend analyses. Section A presents summary statistics to describe civilian patient and hospital characteristics. Section B presents an overall trend analysis of civilian episiotomy rates in all eight states between 2003 and 2008. Section C and D provide readers with the same analysis by payment source and race/ethnicity respectively. The multivariate results will be presented in Chapter V.

A. DESCRIPTIVE STATISTICS OF CIVILIAN PATIENT AND HOSPITAL CHARACTERISTICS

Table 5 presents the descriptive statistics of civilian patient characteristics between 2003 and 2008, based on data extracted from HCUP SID. Approximately 72% of the 648,141 patients who had spontaneous and operative deliveries are between 18 and 29 years old. Only 4% are of age 35 and above. Compared to patients who had spontaneous delivery (74%), a lower proportion (63%) of patients who had operative delivery is between age 18 and 29. However, the proportion of 35 years old and above who had operative delivery (13%) is more than six fold, compared to those who had spontaneous delivery (2%).

In terms of patient's race and ethnicity distribution, Hispanic patients (39%) form the largest race/ethnic group, followed by white patients (33%). About 20% of the sample is black patients and patients of other races. Not surprisingly, of the 8% patients of unknown races, a large proportion is from Washington State as explained earlier.[80] The race/ethnic composition of patients who had spontaneous delivery is similar to that of the overall population. However, among patients who had operative delivery, there are greater proportions of white patients (i.e., 37% vs. 33%) and patients of other races (i.e., 13% vs. 10%), compared to that of the overall population.

[80] Race information is missing for patients from Washington State between 2003 and 2007. To fill the missing information, these observations are assigned "unknown race."

With regard to payment source, 52% of all patients in the population data were covered by Medicaid while 42% were covered by private insurance. Compared to patients who had spontaneous delivery (53%), a lower proportion (45%) of patients who had operative delivery, were covered by Medicaid. A greater proportion (49%) of patients who had operative delivery, were covered by their private insurance than those who had spontaneous delivery (40%).

Table 5. Descriptive statistics of civilian patient characteristics, 2003–2008

	All spontaneous and operative deliveries		**Spontaneous Deliveries**		**Operative Deliveries**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Dependent Variable						
Episiotomy rate (%)	34.3	(47.5)	31.9	(46.6)	51.7	(50.0)
Independent Variables						
Patient Characteristics						
Age						
Age 18 – 24 (%)	40.0	(49.0)	40.6	(49.1)	36.0	(48.0)
Age 25 – 29 (%)	32.4	(46.8)	33.1	(47.0)	27.3	(44.6)
Age 30 – 34 (%)	24.1	(42.8)	24.1	(42.8)	23.8	(42.6)
Age 35 and above (%)	3.5	(18.5)	2.2	(14.8)	12.9	(33.5)
Overall (%)	100.0		100.0		100.0	
Race						
White (%)	32.8	(46.9)	32.2	(46.7)	36.9	(48.3)
Black (%)	10.1	(30.2)	10.5	(30.7)	7.2	(25.9)
Hispanic (%)	39.4	(48.9)	40.1	(49.0)	34.9	(47.7)
Other Races* (%)	10.0	(30.0)	9.6	(29.4)	13.2	(33.8)
Unknown Races** (%)	7.7	(26.6)	7.7	(26.6)	7.7	(26.7)
Overall (%)	100.0		100.0		100.0	
Payment Source						
Medicaid (%)	52.0	(50.0)	53.0	(49.9)	45.0	(49.7)
Private Insurance (%)	41.5	(49.3)	40.4	(49.1)	49.3	(50.0)
Self-pay or No Charge (%)	4.4	(20.6)	4.5	(20.8)	3.6	(18.7)
Others (%)	2.1	(14.4)	2.1	(14.5)	2.1	(14.3)
Overall (%)	100.0		100.0		100.0	
Total number of patients	648,141		568,414		79,727	

Notes: * Other races refer to Asians, Pacific Islanders, Native Americans and other races. ** Unknown races refer to observations with missing value in race. Observations from WA between 2003 and 2007 do not contain information on race in the SID databases.

Source: Generated from data extracted from Healthcare Cost and Utilization Project, Healthcare Cost and Utilization Project State Inpatient Databases, Agency for Healthcare Research and Quality, Rockville, MD: 2003, 2004, 2005, 2006, 2007, and 2008 (accessed October 28, 2011).

Table 6 presents the descriptive statistics of civilian hospital characteristics. The first column presents the summary statistics of all 897 hospitals. We then categorize hospitals by whether they are low- or high-volume episiotomy hospitals, based on percentile of episiotomy rates between 2003 and 2008. Specifically, a hospital is considered a low-volume episiotomy hospital if its overall episiotomy rate is in the lower tertile of the overall episiotomy rate distribution (i.e., below 33rd percentile). A hospital is a high-volume episiotomy hospital if its overall episiotomy rate is in the upper tertile of the distribution (i.e., above 67th percentile). These data are extracted from the American Hospital Association (AHA) annual survey database.

Overall, the mean number of births per hospital is 1,858 births, and the mean number of bassinets is 23 bassinets from the 897 hospitals. This results in an average annual hospital capacity of 81 births per bassinet. The birth-to-bassinet ratios are similar in low- and high-volume episiotomy hospitals.

On average, approximately 71% of the hospitals are not-for-profit hospitals. They have a slightly smaller presence among low-volume hospitals (68%) and bigger presence in the high-volume hospitals (76%). For-profit hospitals are the smallest group, which account for 14%. It is interesting to note that for-profit hospitals are more than double in proportion among high-volume hospitals (18%) when compared to that of low volume hospitals (8%). On the other hand, proportion of government hospitals among those hospitals in the lower tertile is four times that of the hospitals in the upper tertile (24% vs. 6%, respectively).

As a whole, proportion of teaching hospitals is approximately 13% on average. Interestingly, more teaching hospitals are in low-volume category than in the high-volume category (21% vs. 9%, respectively).

With regard to obstetric unit care level, 27% of hospitals in the population data are categorized as not offering any level of obstetric unit care. Approximately 44% of these hospitals provide at least obstetric unit care level two services. Hospitals in both lower and upper 33rd percentiles have comparable distribution of obstetric service lines.

Table 6. Descriptive statistics of civilian hospital characteristics by percentile of episiotomy rates, 2003–2008

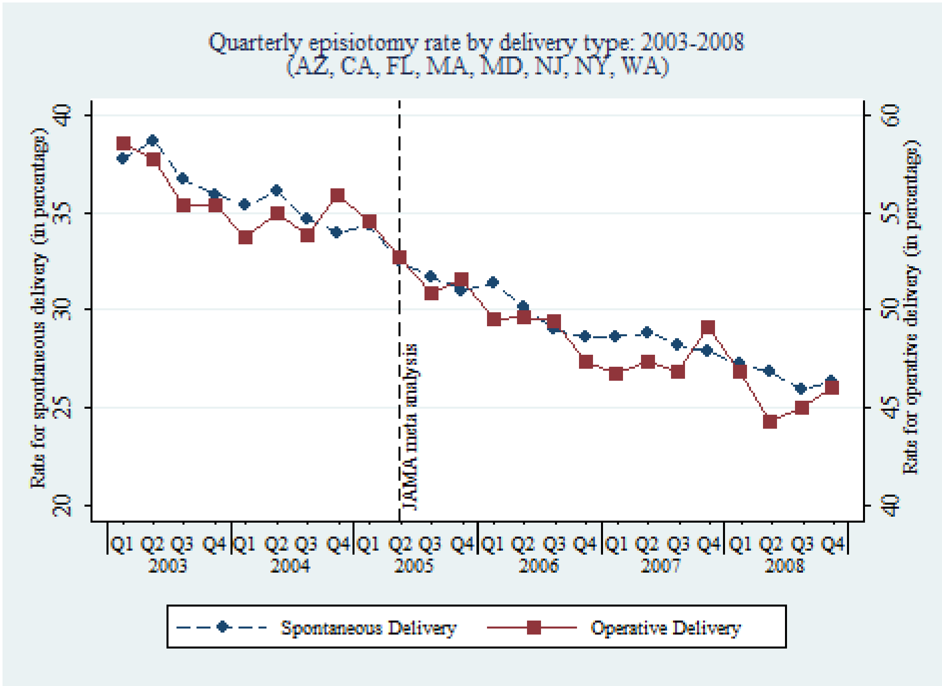
	Overall		Lower 33rd percentile		Upper 33rd percentile	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
<u>Hospital Characteristics</u>						
Births	1,858	(1,824.0)	1,782	(1,979.0)	1,943	1,669
Bassinets	23	(20.4)	21	(21.7)	24	18
Maternity ward turnover (births/bassinets)	80.5	(55.3)	81.4	(60.8)	81.3	57.1
<u>Hospital Type</u>						
For-profit (%)	14.2	(34.1)	8.1	(26.5)	18.0	38.1
Not-for-profit (%)	71.1	(44.5)	67.8	(46.0)	75.9	42.2
Government (%)	14.7	(34.6)	24.1	(42.3)	6.2	23.1
Overall (%)	100.0		100.0		100.0	
<u>Teaching</u>						
Teaching (%)	13.4	(33.3)	20.6	(39.8)	9.1	28.2
Non-teaching (%)	86.6	(33.3)	79.4	(39.8)	90.9	28.2
Overall (%)	100.0		100.0		100.0	
<u>Obstetric Level</u>						
Non-obstetric (%)	26.7	(35.9)	26.6	(36.1)	26.3	35.5
Obstetric Level 1 (%)	29.4	(39.8)	29.3	(39.2)	26.9	39.5
Obstetric Level 2 (%)	24.7	(38.7)	21.4	(36.1)	29.1	41.5
Obstetric Level 3 (%)	19.3	(35.9)	22.7	(37.9)	17.6	35.1
Overall (%)	100.0		100.0		100.0	
Number of Hospitals	897		299		299	

Source: Generated from data extracted from American Hospital Association, AHA Annual Survey Database: 2003, 2004, 2005, 2006, 2007, and 2008 (accessed October 28, 2011).

B. TREND ANALYSIS OF CIVILIAN EPISIOTOMY RATES IN ALL EIGHT STATES BETWEEN 2003 AND 2008

Figure 2 presents the long-term trends in quarterly episiotomy rates from the HCUP SID data between 2003 and 2008. Episiotomy rates for both spontaneous and operative deliveries display steady downward trends even prior to release of the JAMA publication. Numerous clinical trials and research papers published before the JAMA publication could have already influenced practices of episiotomy among practitioners.

Episiotomy rates for both types of deliveries trend similarly during this study period, although episiotomy rates for operative deliveries are consistently higher by approximately 17 to 22 percentage points than that for the spontaneous deliveries during this period. This is consistent with findings by Frankman et al.[81]. No obvious seasonal trends for both delivery types are observed but for the group who had operative delivery, small spikes are apparent in the fourth quarter of 2004, 2005, 2007, and 2008.



Source: Generated using data extracted from Healthcare Cost and Utilization Project, Healthcare Cost and Utilization Project State Inpatient Databases, Agency for Healthcare Research and Quality, Rockville, MD: 2003, 2004, 2005, 2006, 2007, and 2008 (accessed October 28, 2011).

Figure 2. Quarterly civilian episiotomy rates by delivery type, (AZ, CA, FL, MA, MD, NJ, NY and WA, 2003–2008)

Table 7 summarizes the change in civilian episiotomy rates between 2003 and 2008. Episiotomy rates for spontaneous deliveries show a greater proportional decline of 29% between 2003 and 2008, compared to a drop of 20% in episiotomy rates among operative deliveries. The overall decline for all spontaneous and operative deliveries is approximately 28%, which is closer to that for spontaneous deliveries. This is likely due to the significantly greater proportion of spontaneous delivery cases. Table 7 shows that the annual rates of decline for all three groups of deliveries between 2006 and 2008 are generally lower than those between 2003 and 2005. However, these raw rates are

[81] Elizabeth A. Frankman et al., "Episiotomy in the United States," 573.e2.

unadjusted for macro and seasonal trends of episiotomy rates between 2003 and 2008. It is therefore unclear if the rate of decline slows or accelerates after release of the JAMA publication.

Table 7. Change in civilian episiotomy rates, 2003–2008

	Episiotomy Rates (%)		
	All spontaneous and operative deliveries	**Spontaneous deliveries**	**Operative deliveries**
	All eight states (AZ, CA, FL, MA, MD, NJ, NY, WA)		
2003	39.9	37.2	56.7
2005	34.8	32.4	52.4
2006	32.1	29.7	49.0
2008	28.6	26.6	45.5
Annual change (03-05)	-4.3	-4.3	-2.5
Annual change (06-08)	-3.6	-3.5	-2.3

Source: Generated using data extracted from Healthcare Cost and Utilization Project, Healthcare Cost and Utilization Project State Inpatient Databases, Agency for Healthcare Research and Quality, Rockville, MD: 2003, 2005, 2006 and 2008 (accessed October 28, 2011).

Table 8 presents the descriptive statistics of civilian delivery and episiotomy for each of the eight states between 2003 and 2008. The data show that Washington has the lowest episiotomy rates for both spontaneous and operative deliveries during this period. New Jersey records the highest episiotomy rate of 49% for spontaneous deliveries while New York records the highest episiotomy rate of 61% for operative deliveries. California, the largest state by population in the United States, accounts for over 40% of spontaneous deliveries and over 50% of operative deliveries of the sample data extracted from the HCUP SID databases. Since these numbers are raw percentages without adjustment for age and other demographic information, it is not clear whether the substantial variation across states is due to patient demographic differences or due to physician practice pattern differences.

Table 8. Descriptive statistics of civilian delivery and episiotomy by states, (AZ, CA, FL, MA, MD, NJ, NY and WA), 2003–2008

	SD*		**Episiotomy rate (SD*) (%)**		**OD+**		**Episiotomy rate (OD+) (%)**	
	Total patients	**Patients with episiotomy**	**Mean**	**SD**	**Total patients**	**Patients with episiotomy**	**Mean**	**SD**
Arizona	45,535	11,468	25.2%	(43.4%)	4,050	1,918	47.4%	(49.9%)
California	250,252	81,720	32.7%	(46.9%)	40,333	21,303	52.8%	(49.9%)
Florida	92,840	26,161	28.2%	(45.0%)	11,769	5,253	44.6%	(49.7%)
Massachusetts	16,392	4,527	27.6%	(44.7%)	1,972	911	46.2%	(49.9%)
Maryland	12,749	3,423	26.8%	(44.3%)	1,957	958	49.0%	(50.0%)
New Jersey	38,145	18,649	48.9%	(50.0%)	7,098	4,305	60.7%	(48.9%)
New York	92,782	31,765	34.2%	(47.5%)	8,958	5,497	61.4%	(48.7%)
Washington	19,719	3,527	17.9%	(38.3%)	3,590	1,063	29.6%	(45.7%)
Overall	568,414	181,240	31.9%	(46.6%)	79,727	41,208	51.7%	(50.0%)

Notes: * refers to spontaneous deliveries. + refers to operative deliveries.

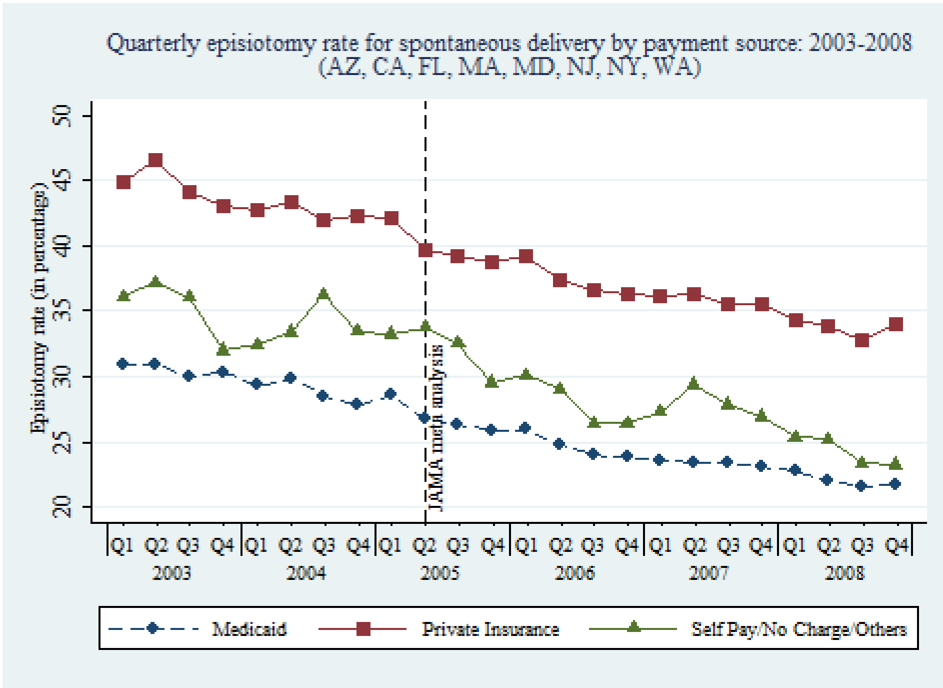
Source: Generated using data extracted from Healthcare Cost and Utilization Project, Healthcare Cost and Utilization Project State Inpatient Databases, Agency for Healthcare Research and Quality, Rockville, MD: 2003, 2004, 2005, 2006, 2007, and 2008 (accessed October 28, 2011).

C. TREND ANALYSIS OF CIVILIAN EPISIOTOMY RATES IN ALL EIGHT STATES BETWEEN 2003 AND 2008 BY PAYMENT SOURCE

To understand whether the episiotomy trends are similar across patients with different types of insurance, mean quarterly episiotomy rates by delivery type in all eight states are obtained for three payment sources: Medicaid, private insurance and other sources including self-pay or no charge (due to small sample size, we combine self-pay, no charge, and other payment sources into one group). Trend lines for each payment source are plotted against time for both spontaneous and operative deliveries. This section discusses the trend for each payment source by delivery type.

1. Spontaneous Delivery

Figure 3 shows the quarterly episiotomy rates for spontaneous delivery by payment source between 2003 and 2008. Similar to the analysis in the earlier section, episiotomy rates for all three groups of payment source display downward trends throughout the period. Episiotomy rates for those who were covered by private insurance are approximately 11 to 16 percentage points higher than that of those who were covered by Medicaid. Episiotomy rates for those who used other sources fluctuate between ranges of the other two payment groups. No distinct seasonal trends are observed for all three groups.

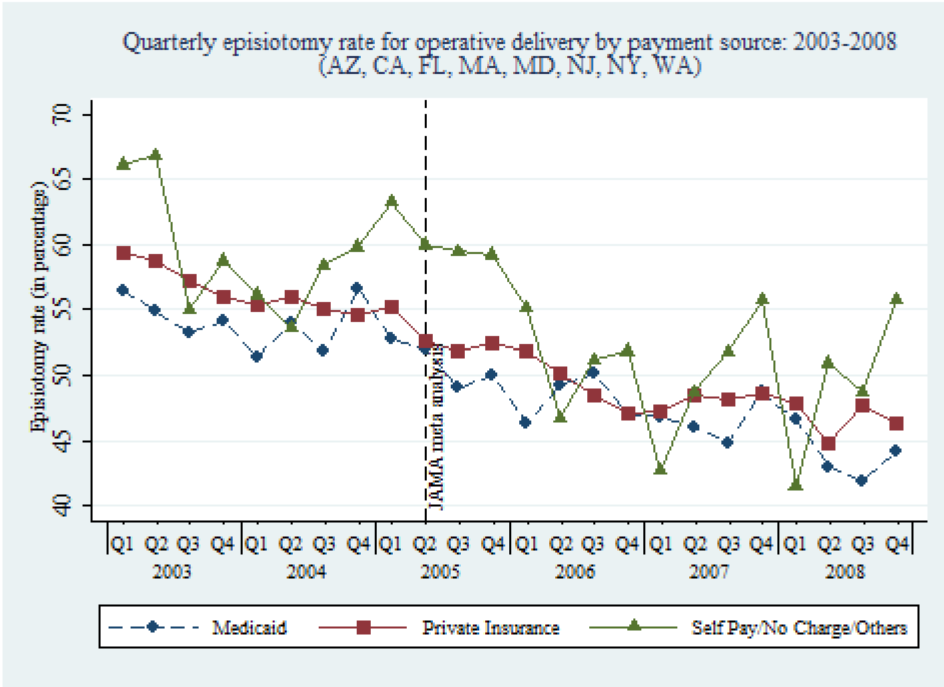


Source: Generated using data extracted from American Hospital Association, Annual Survey Database: 2003, 2004, 2005, 2006, 2007, and 2008 (accessed October 28, 2011).

Figure 3. Quarterly civilian episiotomy rates for spontaneous delivery by payment source, (AZ, CA, FL, MA, MD, NJ, NY and WA, 2003–2008)

2. Operative Delivery

Figure 4 shows the quarterly episiotomy rates for operative delivery by payment source between 2003 and 2008. Episiotomy rates for all three groups of payment sources fluctuate between 40% and 70%, which are persistently higher than those who experienced spontaneous delivery. Consistent with earlier observations for patients who experienced spontaneous delivery, episiotomy rates for all three groups display downward trends. However, unlike episiotomy rates for patients who experienced spontaneous delivery, episiotomy rates for those who had operative delivery and were covered by private insurances are relatively closer to that for the other two groups of payment sources. No distinct seasonal trends are observed for all three groups.



Source: Generated using data extracted from American Hospital Association, Annual Survey Database: 2003, 2004, 2005, 2006, 2007, and 2008 (accessed October 28, 2011).

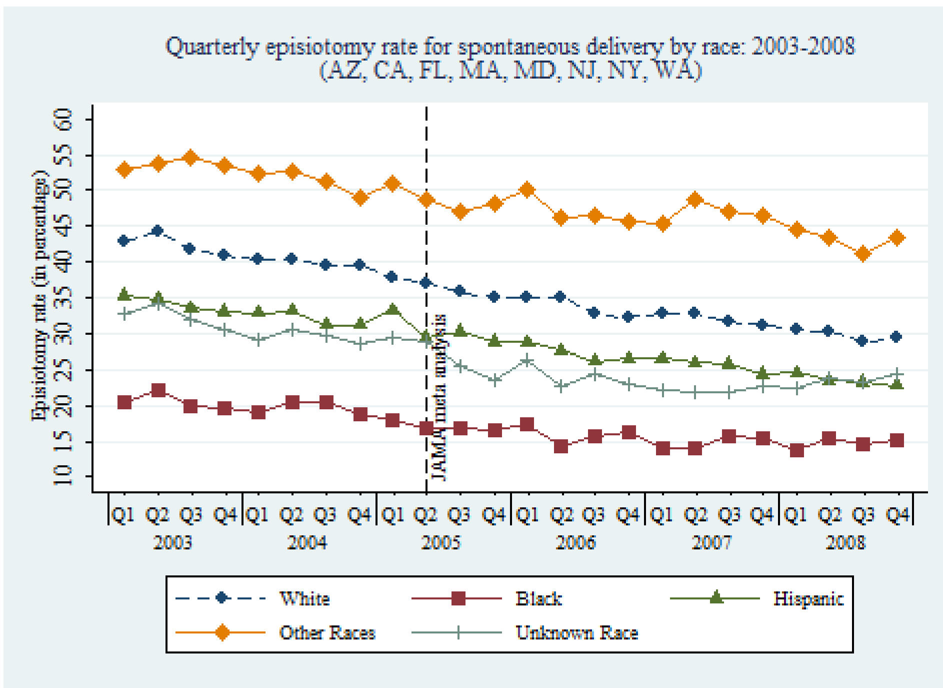
Figure 4. Quarterly civilian episiotomy rates for operative delivery by payment source, (AZ, CA, FL, MA, MD, NJ, NY and WA, 2003–2008)

D. TREND ANALYSIS OF CIVILIAN EPISIOTOMY RATES IN ALL EIGHT STATES BETWEEN 2003 AND 2008 BY RACE

The mean quarterly episiotomy rates by delivery type in all eight states are collected for five races: white, black, Hispanic, other races (include Asian, Pacific Islander, Native American and others) and unknown races (include all patients from Washington State between 2003 and 2007). To determine if the use of episiotomy vary across patients of different races, trend lines for each race are plotted against time for both spontaneous and operative deliveries. This section discusses the trend for each race by delivery type.

1. Spontaneous Delivery

Figure 5 shows the quarterly episiotomy rates for spontaneous delivery by race/ethnic groups between 2003 and 2008. Episiotomy rates for all five race groups generally display downward trends throughout the period. Patients of other races (i.e., Asian, Pacific Islander, Native American, etc) have the highest episiotomy rates among the five race categories, while black patients have the lowest episiotomy rates. Similar to the analysis in the earlier section, no distinct seasonal trends are observed for all five groups.

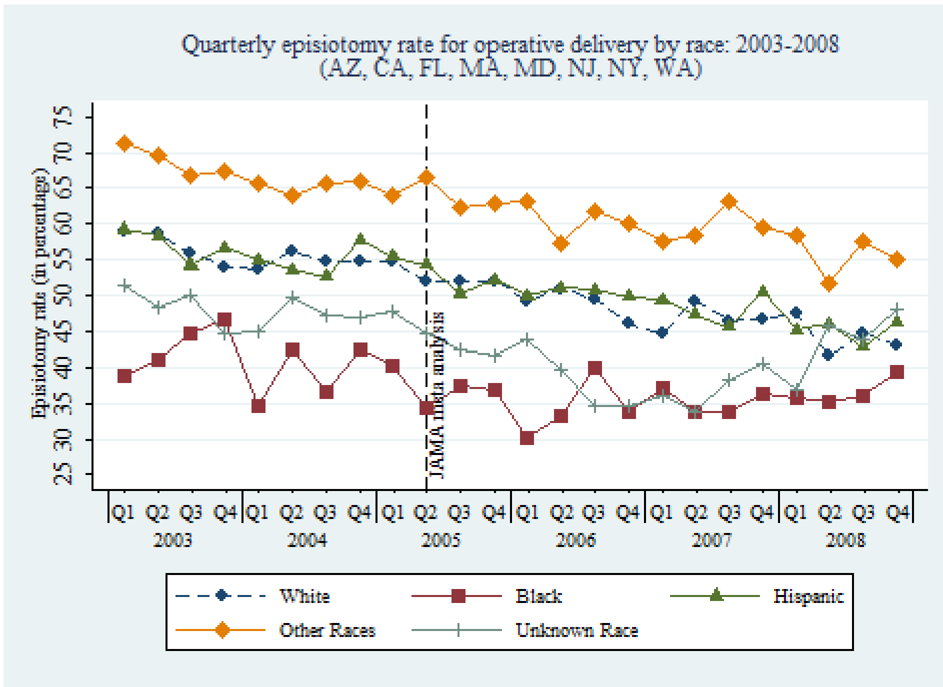


Source: Generated using data extracted from American Hospital Association, Annual Survey Database: 2003, 2004, 2005, 2006, 2007, and 2008 (accessed October 28, 2011).

Figure 5. Quarterly civilian episiotomy rates for spontaneous delivery by race/ethnic group, (AZ, CA, FL, MA, MD, NJ, NY and WA, 2003–2008)

2. Operative Delivery

Figure 6 shows the quarterly episiotomy rates for operative delivery by race/ethnic groups between 2003 and 2008. Differences across the race/ethnic groups are similar to that of spontaneous delivery, in that patients of other races have the highest episiotomy rates and black patients have the lowest episiotomy rates. Episiotomy rates generally display downward trends throughout the period except for black patients. Episiotomy rates for black patients, the lowest among the five groups, remain relatively stable instead of showing a downward trend as the other four race/ethnicity categories. No distinct seasonal trends are observed for all five groups.



Source: Generated using data extracted from American Hospital Association, Annual Survey Database: 2003, 2004, 2005, 2006, 2007, and 2008 (accessed October 28, 2011).

Figure 6. Quarterly civilian episiotomy rates for operative delivery by race/ethnic group, (AZ, CA, FL, MA, MD, NJ, NY and WA, 2003–2008)

E. SUMMARY

Chapter IV provided a preliminary analysis using descriptive statistics and trends for both spontaneous and operative deliveries. Declining episiotomy rates for both delivery types are observed from the raw data but it remains unclear if the rates of decline slows or accelerates after release of the JAMA publication as the raw rates do not take into account macro or seasonal factors between 2003 and 2008. The data also shows considerable variations in episiotomy rates across states. However, these raw percentages are unadjusted for age and other demographic information. We are therefore unable to attribute these observed variations across states to differences in patient demographics or physician practice patterns. Episiotomy rates for each of the three payment sources and five race groups for both delivery types varies substantially in the baseline, but show little or no discernible trend differences. This thesis explicitly controls for these patient characteristics in the multivariate analysis. The next chapter analyzes results from the multivariate regressions described in Chapter III, to determine whether release of the JAMA publication has had an effect on episiotomy rates in the eight states.

V. MULTIVARIATE ANALYSIS AND RESULTS

This chapter presents results from the multivariate analyses. Section A discusses results from the main multivariate models that analyze the effect of the release of the JAMA publication on episiotomy rates while controlling for hospital and patient characteristics. Section B discusses results from additional models that test the sensitivity of the main results, including models that control for sizes (proxied by number of births in 1,000s, and normalized so a hospital with an average number of births has the value zero), with/without maternity ward turnover (defined as ratio of births (in 1,000s)-to-bassinets), and models that restrict sample to larger hospitals. Section C discusses results analyzing variations of practice patterns between 2003 and 2008.

A. EFFECT OF JAMA PUBLICATION ON EPISIOTOMY RATES

Of the initial 897 hospitals, only 671 hospitals are included for the multivariate analysis (75% of the initial hospital sample): 48 hospitals are dropped due to missing AHA hospital identifiers in the SID data; another 178 hospitals are dropped because they reported no delivery (of any kind) for some years of the study period. We exclude those extremely low-volume hospitals to minimize unnecessary variances (or noise) in estimation. Table 9 presents the marginal effects from both the fixed effects and random effects estimations for three patient cohorts. The first three columns present results from fixed-effects models for the following patient cohorts: (1) patients who had spontaneous delivery, (2) patients who had operative delivery, and (3) all patients regardless of delivery type. The last three columns present the results from random-effects models for the same three groups of patients. As explained in Chapter III, while the fixed-effects model is preferred because it controls for the underlying heterogeneity across hospitals, the random effects estimations are used to gain additional insight on the effects of time-invariant hospital characteristics on episiotomy rates in the eight states.

Table 9. Main multivariate results (fixed and random effects, hospitals with at least one delivery per year between 2003 and 2008)

VARIABLES	**Spontaneous delivery (FE) epi_rate**	**Operative delivery (FE) epi_rate**	**Both delivery types (FE) epi_rate**	**Spontaneous delivery (RE) epi_rate**	**Operative delivery (RE) epi_rate**	**Both delivery types (RE) epi_rate**
JAMA dummy	-2.06**	-1.74	-1.75**	-2.12**	-1.82	-1.87**
(1 if date > 2005 qtr 2)	(0.84)	(1.46)	(0.86)	(0.94)	(1.55)	(0.93)
Delivery Type			12.23***			12.30***
(1 if Operative)			(0.64)			(0.64)
Interaction Terms						
JAMA x for-profit	1.26	1.23	0.97	1.44	1.35	1.14
hospitals	(0.99)	(1.72)	(1.15)	(1.04)	(1.74)	(1.18)
JAMA x government	1.60*	1.90	1.64*	2.08**	2.59*	2.29**
hospitals	(0.92)	(1.30)	(0.88)	(0.98)	(1.38)	(0.94)
JAMA x teaching	-0.92	-0.77	-1.05	-1.20	-0.93	-1.27
Hospitals	(0.82)	(1.52)	(0.94)	(0.88)	(1.54)	(0.97)
JAMA x obstetric level 1	-0.84	-0.34	-0.71	-0.50	-0.04	-0.33
	(0.74)	(1.15)	(0.75)	(0.99)	(1.39)	(0.95)
JAMA x obstetric level 2	-0.74	-1.02	-0.97	-1.05	-1.54	-1.37
	(0.71)	(1.20)	(0.75)	(0.88)	(1.43)	(0.91)
JAMA x obstetric level 3	0.60	-0.67	0.03	0.55	-0.70	0.11
	(0.74)	(1.35)	(0.82)	(0.93)	(1.59)	(1.02)
Hospital Characteristics						
For-profit hospitals				0.63	3.04*	2.45
				(1.42)	(1.77)	(1.51)
Government hospitals				-5.84***	-3.05*	-5.02***
				(1.61)	(1.57)	(1.42)
Teaching hospitals				0.21	-2.00	-1.47
				(1.34)	(1.89)	(1.56)
Obstetric level 1				-0.82	-0.93	-0.75
				(0.95)	(1.34)	(0.94)
Obstetric level 2				0.90	0.80	0.79
				(0.88)	(1.35)	(0.94)
Obstetric level 3				0.22	-0.21	-0.35
Patient Composition						
Percent (self-pay/no	5.56***	24.81***	22.21***	5.89***	25.61***	22.36***
charge)	(1.89)	(2.57)	(1.92)	(1.84)	(2.55)	(1.91)
Percent (private insurance)	10.34***	29.41***	28.11***	11.25***	29.54***	28.08***
	(1.48)	(1.70)	(1.31)	(1.42)	(1.63)	(1.28)
Percent (age 25 - 29)	-2.25*	8.71***	8.66***	-2.08	9.87***	8.99***
	(1.32)	(1.65)	(1.20)	(1.32)	(1.64)	(1.19)
Percent (age 30 - 34)	-2.25	3.50**	5.37***	-1.44	4.54***	5.85***
	(1.41)	(1.74)	(1.31)	(1.40)	(1.73)	(1.31)
Percent (age 35 and above)	-6.24*	2.97	3.69*	-5.53	3.51	4.08**
	(3.67)	(2.26)	(1.92)	(3.67)	(2.25)	(1.92)

VARIABLES	Spontaneous delivery (FE) epi_rate	Operative delivery (FE) epi_rate	Both delivery types (FE) epi_rate	Spontaneous delivery (RE) epi_rate	Operative delivery (RE) epi_rate	Both delivery types (RE) epi_rate
Percent (black)	-10.51***	15.54***	10.88***	-9.96***	17.31***	11.15***
	(2.39)	(2.86)	(2.09)	(2.16)	(2.76)	(2.02)
Percent (hispanic)	-1.34	23.95***	18.22***	-0.10	26.61***	19.03***
	(1.65)	(1.95)	(1.61)	(1.49)	(1.79)	(1.54)
Percent (other races)	7.42***	18.80***	17.46***	8.73***	20.85***	18.16***
	(2.00)	(2.17)	(1.93)	(1.97)	(2.14)	(1.93)
Percent (unknown races)	2.69*	22.02***	14.57***	1.13	18.96***	13.12***
	(1.61)	(2.37)	(1.50)	(1.51)	(2.34)	(1.47)
Year and Quarter Dummies						
2004	-1.49***	-1.52**	-1.53***	-1.48***	-1.48**	-1.53***
	(0.42)	(0.74)	(0.43)	(0.41)	(0.74)	(0.43)
2005	-2.38***	-1.45	-1.94***	-2.37***	-1.37	-1.92***
	(0.67)	(1.23)	(0.70)	(0.67)	(1.22)	(0.70)
2006	-4.30***	-4.49***	-4.48***	-4.26***	-4.39***	-4.44***
	(0.79)	(1.46)	(0.85)	(0.79)	(1.46)	(0.84)
2007	-6.00***	-5.22***	-5.76***	-5.91***	-5.05***	-5.65***
	(0.81)	(1.47)	(0.86)	(0.82)	(1.46)	(0.85)
2008	-7.05***	-5.84***	-6.55***	-7.04***	-5.63***	-6.47***
	(0.81)	(1.47)	(0.86)	(0.81)	(1.47)	(0.85)
Quarter 2	-0.16	-0.21	-0.23	-0.18	-0.16	-0.23
	(0.26)	(0.62)	(0.34)	(0.26)	(0.62)	(0.34)
Quarter 3	-0.89***	-0.58	-0.74**	-0.92***	-0.63	-0.76**
	(0.29)	(0.61)	(0.35)	(0.29)	(0.61)	(0.35)
Quarter 4	-1.24***	-0.06	-0.54	-1.25***	-0.08	-0.56
	(0.29)	(0.67)	(0.38)	(0.29)	(0.68)	(0.38)
Constant	30.16***	15.04***	5.32***	29.93***	14.34***	5.66***
	(1.23)	(0.93)	(0.92)	(1.49)	(1.29)	(1.09)
Observations	16,104	16,104	32,208	16,104	16,104	32,208
R-squared	0.095	0.224	0.215			
Number of hospitals	671	671	671	671	671	671

Notes: Robust standard errors in parentheses.
* significant at 10%, ** significant at 5%, *** significant at 1%.

The key objective of this thesis is to provide empirical evidence to demonstrate or disprove claims that findings from the JAMA publication have led to declines in practices of episiotomy. A JAMA indicator, which takes on the value one on and after the second quarter of 2005 (when the article was published), is therefore specified in all the regression models as one of the key explanatory variables. Both the fixed effects and random effects regression results show that, after controlling for year and seasonal trends, patients who had spontaneous delivery after the release of the JAMA publication are less likely to undergo episiotomy by approximately 2.1 percentage points. The JAMA indicator was not statistically significant at the 10% level when restricting the sample to just operative deliveries. The regression results (3rd column, Table 9) also show that patients who had operative delivery are more likely to undergo episiotomy by 12 percentage points, compared to those who had spontaneous delivery. In this basic model, there does not appear to be differential responses to JAMA publication by hospital characteristics (i.e., no statistically significant coefficients among the interaction terms between JAMA indicator and hospital characteristics), except that government hospitals have much smaller response to the publication, compared to hospitals of other ownership structures (the government hospitals' episiotomy rate decreases by just 0.8 percentage point after JAMA publication [2.06-1.26=0.8]).

Next, we focus on the results showing differences in episiotomy rates across different types of hospitals. As previously discussed in Chapter III, physicians in for-profit hospitals are expected to be less willing to abandon episiotomy practice, compared to physicians in government or not-or profit hospitals. Results from the random effects regressions show that patients who had operative delivery are more likely to undergo episiotomy in for-profit hospitals, by about three percentage points, compared to those in not-for-profit hospitals. All three patient cohorts are also less likely to undergo episiotomy in government hospitals, by 3–6 percentage points, compared to those in not-for-profit hospitals.

In Chapter III, we hypothesize that teaching hospitals are more receptive and hence more likely to adopt recommendations from major publications like the JAMA article. We also expect hospitals that can handle more complicated obstetric cases are more likely to adopt recommendations from the JAMA article. However, the empirical results do not support either hypothesis.

The next panel of Table 9 presents the results from the patient composition control variables in the model and shows that in general, episiotomy rates also vary considerably by the patient composition in each hospital (without controlling for the underlying patient composition, the estimated effect of JAMA publication would be much bigger). The last panel shows that episiotomy rates generally decline between 2004 and 2008, but there is no clear seasonal trend.

B. EFFECT OF JAMA PUBLICATION ON EPISIOTOMY RATES WITH CONTROLS FOR NORMALIZED BIRTH SIZES AND HOSPITAL CAPACITY

Section B presents additional models to test the robustness of the main results. Tables 10–13 present the marginal effects from fixed effects and random effects regression models that control for sizes, with/without maternity ward turnover, for the same three patient cohorts: (1) patients who had spontaneous delivery (columns 1 and 2 of Tables 10–13), (2) patients who had operative delivery (columns 3 and 4 of Tables 10–13), and (3) all patients from (1) and (2) (columns 5 and 6 of Tables 10–13). We use number of births in 1,000s, and normalized (so a hospital with an average number of births has the value zero) as proxy for sizes. As previously discussed in Chapter III, we define maternity ward turnover as ratio of births (in 1,000s)-to-bassinets and use it as proxy for patient demand. We hypothesize that the release of the JAMA article is less likely to lower episiotomy rates in hospitals with higher annual turnover rate. See Appendix A and B for complete results from the fixed and random effects models.

1. Fixed Effects Regressions

Table 10 presents the marginal effects from fixed effects regression models that control for sizes, with/without maternity ward turnover, for each of the three patient cohorts in 671 hospitals. The fixed effects regression results, after controlling for year and seasonal trends, sizes and maternity ward turnover, are consistent with the earlier results in Section A.

Table 10. Multivariate results (fixed effects with additional controls for normalized births and hospital capacity, hospitals with at least one delivery per year between 2003 and 2008)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
JAMA dummy	-2.13**	-2.60***	-1.91	-0.06	-1.87**	-1.13
(1 if date > 2005 qtr 2)	(0.83)	(0.93)	(1.45)	(1.63)	(0.86)	(0.97)
Delivery Type					12.23***	12.23***
(1 if Operative)					(0.64)	(0.64)
Interaction Terms						
JAMA x normalized births	-0.32*	-0.38**	-0.83***	-0.58*	-0.55***	-0.45**
	(0.18)	(0.17)	(0.31)	(0.32)	(0.20)	(0.21)
JAMA x births (in '000)		5.94		-23.62***		-9.40*
per year per bassinet		(5.25)		(8.56)		(5.37)
JAMA x for-profit hospitals	1.22	1.11	1.14	1.59	0.91	1.09
	(0.99)	(1.01)	(1.71)	(1.74)	(1.15)	(1.17)
JAMA x government	1.45	1.35	1.51	1.90	1.39	1.54*
hospitals	(0.92)	(0.93)	(1.31)	(1.32)	(0.89)	(0.90)
JAMA x teaching	-0.55	-0.51	0.20	0.06	-0.41	-0.46
hospitals	(0.82)	(0.81)	(1.56)	(1.56)	(0.95)	(0.95)
JAMA x obstetric level 1	-0.94	-0.93	-0.59	-0.62	-0.88	-0.89
	(0.75)	(0.75)	(1.15)	(1.15)	(0.76)	(0.76)
JAMA x obstetric level 2	-0.58	-0.66	-0.61	-0.30	-0.70	-0.58
	(0.70)	(0.71)	(1.21)	(1.22)	(0.76)	(0.77)
JAMA x obstetric level 3	1.00	0.96	0.37	0.50	0.71	0.76
	(0.76)	(0.76)	(1.44)	(1.44)	(0.86)	(0.86)
Hospital Characteristics						
Normalized births ((births –	0.31	0.30	0.87	0.84	0.57	0.53
mean(births)) / 1,000)	(0.29)	(0.31)	(0.55)	(0.60)	(0.37)	(0.39)
Births (in '000) per year		-1.85		10.69		5.35
per bassinet		(6.29)		(11.03)		(6.98)
Constant	30.12***	30.28***	14.92***	14.04***	5.24***	4.80***
	(1.23)	(1.31)	(0.93)	(1.25)	(0.92)	(1.05)
Observations	16,104	16,104	16,104	16,104	32,208	32,208
R-squared	0.095	0.095	0.224	0.225	0.215	0.215
Number of hospitals	671	671	671	671	671	671

Notes: All models include patient composition, year and quarter dummies. Robust standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Similar to the main results in Table 9, patients who had spontaneous delivery after the release of the JAMA publication are less likely to undergo episiotomy by 2.1–2.6 percentage points. The JAMA indicator is also not statistically significant at the 10% level when restricting the sample to just operative deliveries.

Most of the hospital characteristics do not show a differential response to the JAMA publication, except for birth volume and maternity ward turnover. The regression results show that for all three patient cohorts, hospitals with bigger birth volume have slightly bigger responses to the JAMA publication: episiotomy rates among women delivering in hospitals whose annual birth volume is 1,000 above the average are predicted to decrease marginally by less than one percentage point compared to hospitals with an average birth volume after release of the JAMA article. Maternity ward turnover rate is not a factor in affecting episiotomy rate for spontaneous delivery. However, when restricting the sample to just operative deliveries, episiotomy rate for women who deliver in hospitals which handle 1,000 more births per bassinets per year, after the JAMA publication, is likely to decrease by 24 percentage points.

Table 11 presents fixed effects regression results that replicate the models from Table 10 but restrict the hospital sample to those that have at least 25 deliveries per year. The purpose of this set of models is to test whether the results above are driven by low-volume hospitals. Again, coefficients of the key variables are consistent with previous models, and the estimated effects are marginally larger when restricting to this high-volume sample.

Table 11. Multivariate results (fixed effects with additional controls for normalized births and hospital capacity, hospitals with at least 25 deliveries per year between 2003 and 2008)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
JAMA dummy	-2.30***	-2.74***	-0.89	1.02	-1.59*	-0.76
(1 if date > 2005 qtr 2)	(0.68)	(0.81)	(1.72)	(1.94)	(0.92)	(1.06)
Delivery Type					13.46***	13.46***
(1 if Operative)					(0.70)	(0.70)
Interaction Terms						
JAMA x normalized births	-0.24	-0.29	-0.75**	-0.54	-0.47**	-0.37*
	(0.18)	(0.18)	(0.35)	(0.35)	(0.22)	(0.22)
JAMA x births (in '000)		5.23		-22.91**		-10.04*
per year per bassinet		(5.42)		(9.56)		(5.95)
JAMA x for-profit	1.19	1.11	0.40	0.79	0.52	0.71
hospitals	(0.97)	(0.99)	(1.83)	(1.86)	(1.19)	(1.21)
JAMA x government	1.32	1.20	2.10	2.66	1.50	1.75
hospitals	(0.92)	(0.94)	(1.71)	(1.76)	(1.09)	(1.12)
JAMA x teaching	-0.01	0.03	-0.58	-0.74	-0.41	-0.47
hospitals	(0.83)	(0.83)	(1.67)	(1.68)	(1.03)	(1.03)
JAMA x obstetric level 1	-0.30	-0.30	-1.45	-1.42	-1.04	-1.02
	(0.78)	(0.78)	(1.51)	(1.51)	(0.93)	(0.93)
JAMA x obstetric level 2	-0.35	-0.42	-0.61	-0.32	-0.59	-0.47
	(0.66)	(0.67)	(1.39)	(1.40)	(0.82)	(0.83)
JAMA x obstetric level 3	0.64	0.63	0.43	0.51	0.57	0.61
	(0.72)	(0.73)	(1.57)	(1.56)	(0.91)	(0.91)
Hospital Characteristics						
Normalized births ((births	0.30	0.28	0.67	0.55	0.46	0.36
– mean(births)) / 1,000)	(0.31)	(0.34)	(0.57)	(0.61)	(0.38)	(0.41)
Births (in '000) per year		-1.07		14.83		8.60
per bassinet		(6.76)		(11.77)		(7.41)
Constant	33.20***	33.33***	17.56***	16.25***	5.18***	4.44***
	(1.89)	(1.90)	(1.15)	(1.50)	(1.10)	(1.25)
Observations	12,816	12,816	12,816	12,816	25,632	25,632
R-squared	0.134	0.134	0.211	0.211	0.226	0.226
Number of hospitals	534	534	534	534	534	534

Notes: All models include patient composition, year and quarter dummies. Robust standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

2. Random Effects Regressions

Table 12 presents the marginal effects from random effects regression models that control for sizes with and without maternity ward turnover for each of the three patient cohorts in 671 hospitals. Like the fixed effects models, the random effects regression results, after controlling for year and seasonal trends, hospital sizes and maternity ward turnover, are consistent with earlier results in Section A.

Table 12. Multivariate results (random effects with additional controls for normalized births and hospital capacity, hospitals with at least one delivery per year between 2003 and 2008)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
JAMA dummy	-2.21**	-2.61***	-2.13	-0.17	-2.06**	-1.27
(1 if date > 2005 qtr 2)	(0.93)	(1.00)	(1.54)	(1.70)	(0.93)	(1.02)
Delivery Type					12.28***	12.29***
(1 if Operative)					(0.64)	(0.64)
Interaction Terms						
JAMA x normalized births	-0.25	-0.31*	-0.82**	-0.54	-0.50**	-0.39*
	(0.18)	(0.18)	(0.33)	(0.33)	(0.21)	(0.21)
JAMA x births (in ‘000)		5.19		-25.64***		-10.40*
per year per bassinet		(5.23)		(8.64)		(5.35)
JAMA x for-profit hospitals	1.41	1.30	1.21	1.75	1.07	1.28
	(1.04)	(1.06)	(1.73)	(1.76)	(1.18)	(1.20)
JAMA x government	1.96**	1.86*	2.26	2.75*	2.08**	2.29**
hospitals	(0.98)	(0.99)	(1.39)	(1.42)	(0.95)	(0.96)
JAMA x teaching hospitals	-0.93	-0.90	-0.01	-0.15	-0.72	-0.78
	(0.88)	(0.88)	(1.59)	(1.60)	(0.99)	(0.99)
JAMA x obstetric level 1	-0.56	-0.55	-0.25	-0.28	-0.46	-0.48
	(0.99)	(0.99)	(1.38)	(1.38)	(0.95)	(0.95)
JAMA x obstetric level 2	-0.86	-0.95	-0.94	-0.51	-1.00	-0.82
	(0.88)	(0.89)	(1.46)	(1.46)	(0.93)	(0.93)
JAMA x obstetric level 3	0.99	0.95	0.78	0.98	1.02	1.11
	(0.96)	(0.97)	(1.67)	(1.67)	(1.07)	(1.08)
Hospital Characteristics						
Normalized births ((births –	0.67**	0.70**	1.13***	0.92**	0.82**	0.77**
mean(births)) / 1,000)	(0.28)	(0.30)	(0.41)	(0.42)	(0.32)	(0.33)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
Births (in '000) per year		-3.26		18.12**		5.55
per bassinet		(6.19)		(8.71)		(6.26)
For-profit hospitals	0.95	1.01	3.35*	2.97*	2.75*	2.63*
	(1.42)	(1.43)	(1.76)	(1.77)	(1.51)	(1.52)
Government hospitals	-5.77***	-5.67***	-2.63*	-3.01*	-4.78***	-4.93***
	(1.59)	(1.60)	(1.57)	(1.57)	(1.41)	(1.41)
Teaching hospitals	-0.59	-0.60	-3.40*	-3.31	-2.46	-2.45
	(1.36)	(1.36)	(2.02)	(2.02)	(1.64)	(1.65)
Obstetric level 1	-0.82	-0.84	-0.76	-0.69	-0.69	-0.66
	(0.95)	(0.95)	(1.33)	(1.32)	(0.93)	(0.93)
Obstetric level 2	0.69	0.73	0.23	-0.01	0.45	0.37
	(0.88)	(0.88)	(1.36)	(1.36)	(0.94)	(0.94)
Obstetric level 3	-0.34	-0.32	-1.71	-1.80	-1.23	-1.28
	(0.92)	(0.93)	(1.64)	(1.63)	(1.09)	(1.09)
Constant	30.12***	30.36***	14.75***	13.45***	5.88***	5.49***
	(1.50)	(1.56)	(1.30)	(1.45)	(1.10)	(1.20)
Observations	16,104	16,104	16,104	16,104	32,208	32,208
Number of hospitals	671	671	671	671	671	671

Notes: All models include patient composition, year and quarter dummies. Robust standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Patients who had spontaneous delivery after the release of the JAMA publication are less likely to undergo episiotomy by 2.2–2.6 percentage points. For operative deliveries, the JAMA indicator is not statistically significant at the 10% level. In addition, patients who had operative delivery are more likely to undergo episiotomy by about 12 percentage points, compared to those who had spontaneous delivery.

Most of the hospital characteristics do not show a differential response to the JAMA publication, except for government hospitals, hospital sizes and maternity ward turnover. For all patients, regardless of delivery type, episiotomy rates among women delivering in hospitals whose annual birth volume is 1,000 above the average are predicted to decrease marginally by 0.4–0.5 percentage point after release of the JAMA article. For operative deliveries, episiotomy rate for women who deliver in hospitals which handle 1,000 more births per bassinets per year, after the JAMA publication, is likely to decrease by 26 percentage points. Both estimated effects are similar to the results from the fixed effects models. The regression results also show that for all three patient cohorts, episiotomy rates among women delivering in government hospitals increase marginally by 2–3 percentage points after release of the JAMA study. Results pertaining to other hospital characteristics are similar to the main models in Table 9.

Table 13 presents the marginal effects from random effects regression models that restrict the hospital sample to 534 hospitals with at least 25 episiotomy patients per year between 2003 and 2008. In general, the results are consistent with previous results from the unrestricted patient cohorts from 671 hospitals, except for the effects of hospital size, which are statistically insignificant at the 10% level for the restricted sample.

Table 13. Multivariate results (random effects with additional controls for normalized births and hospital capacity, hospitals with at least 25 deliveries per year between 2003 and 2008)

	Spontaneous delivery without control for maternity ward turnover	**Spontaneous delivery with control for maternity ward turnover**	**Operative delivery without control for maternity ward turnover**	**Operative delivery with control for maternity ward turnover**	**Both delivery types without control for maternity ward turnover**	**Both delivery types with control for maternity ward turnover**
VARIABLES	**epi_rate**	**epi_rate**	**epi_rate**	**epi_rate**	**epi_rate**	**epi_rate**
JAMA dummy	-2.53***	-2.90***	-0.94	1.06	-1.72*	-0.81
(1 if date > 2005 qtr 2)	(0.78)	(0.86)	(1.84)	(2.03)	(0.99)	(1.11)
Delivery Type					13.46***	13.47***
(1 if Operative)					(0.70)	(0.70)
Interaction Terms						
JAMA x normalized births	-0.20	-0.24	-0.72**	-0.49	-0.42*	-0.32
	(0.18)	(0.18)	(0.36)	(0.36)	(0.23)	(0.23)
JAMA x births (in ‘000)		4.62		-24.69**		-11.17*
per year per bassinet		(5.36)		(9.70)		(5.94)
JAMA x for-profit hospitals	1.25	1.17	0.23	0.67	0.53	0.73
	(1.03)	(1.05)	(1.87)	(1.90)	(1.23)	(1.24)
JAMA x government	1.94**	1.81*	3.03*	3.75**	2.41**	2.74**
hospitals	(0.98)	(1.02)	(1.83)	(1.91)	(1.17)	(1.22)
JAMA x teaching hospitals	-0.40	-0.36	-0.46	-0.66	-0.57	-0.66
	(0.92)	(0.92)	(1.72)	(1.73)	(1.08)	(1.08)
JAMA x obstetric level 1	0.44	0.44	-1.08	-1.06	-0.55	-0.54
	(1.02)	(1.02)	(1.80)	(1.80)	(1.14)	(1.15)
JAMA x obstetric level 2	-0.51	-0.59	-1.19	-0.78	-1.04	-0.85
	(0.84)	(0.85)	(1.68)	(1.69)	(1.01)	(1.02)
JAMA x obstetric level 3	0.82	0.79	0.18	0.34	0.58	0.65
	(0.95)	(0.95)	(1.85)	(1.85)	(1.16)	(1.16)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
Hospital Characteristics						
Normalized births ((births –	0.36	0.36	0.60	0.43	0.45	0.38
mean(births)) / 1,000)	(0.28)	(0.31)	(0.43)	(0.44)	(0.34)	(0.35)
Births (in '000) per year		-2.15		18.11**		7.83
per bassinet		(6.49)		(9.19)		(6.57)
For-profit hospitals	0.17	0.19	3.57*	3.28*	2.59*	2.49
	(1.42)	(1.43)	(1.85)	(1.85)	(1.53)	(1.54)
Government hospitals	-5.04***	-4.92***	-1.70	-2.29	-4.56***	-4.85***
	(1.51)	(1.51)	(1.99)	(2.02)	(1.44)	(1.45)
Teaching hospitals	-0.24	-0.26	-3.43	-3.26	-2.83	-2.75
	(1.44)	(1.44)	(2.19)	(2.19)	(1.73)	(1.73)
Obstetric level 1	-1.41	-1.42	-0.50	-0.45	-0.76	-0.73
	(1.04)	(1.04)	(1.62)	(1.61)	(1.10)	(1.09)
Obstetric level 2	0.35	0.39	0.25	0.01	0.51	0.41
	(0.90)	(0.90)	(1.51)	(1.51)	(1.03)	(1.03)
Obstetric level 3	-0.53	-0.50	-0.61	-0.70	-0.65	-0.69
	(0.94)	(0.94)	(1.82)	(1.81)	(1.19)	(1.19)
Constant	33.28***	33.46***	17.01***	15.61***	5.78***	5.16***
	(2.04)	(2.03)	(1.52)	(1.66)	(1.25)	(1.34)
Observations	12,816	12,816	12,816	12,816	25,632	25,632
Number of hospitals	534	534	534	534	534	534

Notes: All models include patient composition, year and quarter dummies. Robust standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

C. ANALYSIS OF VARIATIONS IN PRACTICE PATTERNS BETWEEN 2003 AND 2008

Another useful metric to examine whether comparative effectiveness study has the desirable impact on clinical practices is by examining practice variations over time. Figures 7–10 display variances of episiotomy practice patterns across hospitals between 2003 and 2008, in both number of episiotomies and episiotomy rates, for two patient cohorts, namely: (1) patients who had spontaneous delivery and (2) patients who had operative delivery. Tables 14–17 present the practice variations across hospitals between 2003 and 2008, in both number of episiotomies and episiotomy rates by percentiles, for the same two patient cohorts. Hospitals with less than ten episiotomy patients per year between 2003 and 2008, are dropped from both samples to minimize unnecessary variances (or noise) caused by hospitals with very low patient volumes. These graphs and tables provide a more in-depth analysis to determine if variations in use of episiotomy are declining.

1. Spontaneous Delivery

Figure 7 displays variances of episiotomy practice patterns across 663 (74% of initial 897, 234 hospitals with fewer than ten patients in a year are dropped) hospitals between 2003 and 2008, in number of episiotomies, for patients who had spontaneous delivery. Table 14 presents a detailed summary of the practice variations across hospitals between 2003 and 2008.

Figure 7 shows a declining trend in variances of episiotomy use across hospitals between 2003 and 2008. The median number of episiotomies, as indicated by the line in the box of the box-and-whisker plot, for patients who had spontaneous delivery is also declining. The mean number of episiotomies, as shown in the first column of Table 14, for patients who had spontaneous delivery is also declining. This suggests that the number of patients who undergo episiotomy in this group is declining. The narrowing interquartile ranges (in the last column of Table 14) as well as the box-and-whisker plot in Figure 7 suggest that variation in episiotomy practice by volume for this group of patients is decreasing.

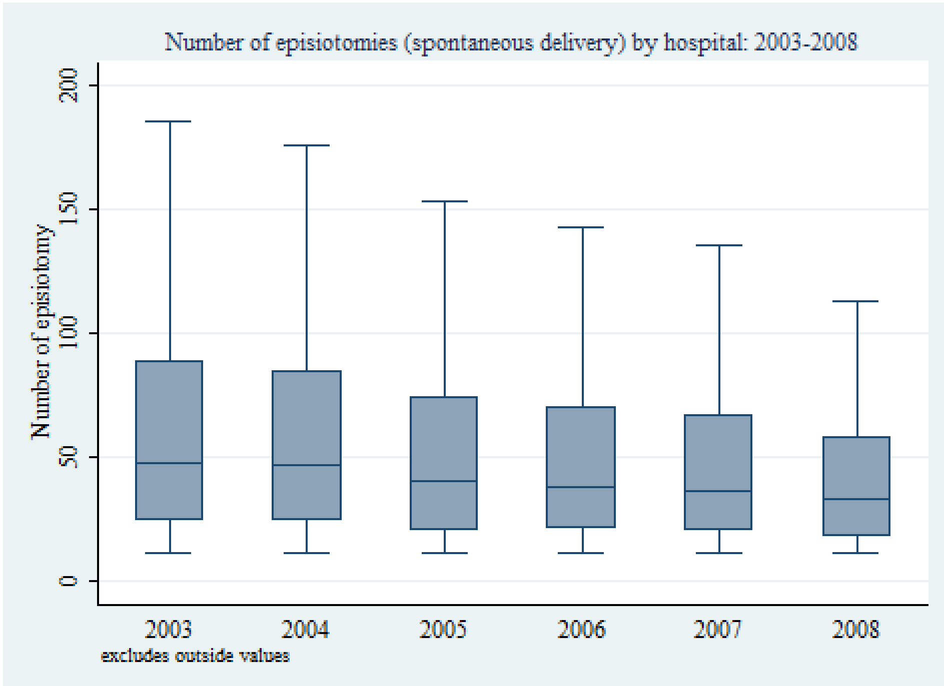


Figure 7. Variances of practice patterns (in number of episiotomies) for spontaneous delivery between 2003 and 2008

Table 14. Practice variation (in number of episiotomies) for spontaneous delivery between 2003 and 2008 by percentiles

	Mean	SD	Percentiles 5th	25th	75th	95th	Interquartile range
State Inpatient Discharge Data: 663 Hospitals*							
2003	69.75	69.62	13.00	24.00	89.00	200.00	65.00
2004	66.49	64.51	13.00	24.00	85.00	184.00	61.00
2005	59.65	60.53	12.00	20.00	74.00	170.00	54.00
2006	56.78	59.53	12.00	21.00	70.00	160.00	49.00
2007	54.71	57.95	12.00	20.00	67.00	150.00	47.00
2008	49.63	52.62	12.00	18.00	58.00	141.00	40.00

Notes: Exclude hospitals with less than ten episiotomy patients in a year between 2003 and 2008.

The declining and narrowing interquartile range on episiotomy volume could be due to declining number of women giving birth through spontaneous delivery. Therefore Figure 8 displays variances of episiotomy rates (instead of volume) across 663 hospitals between 2003 and 2008 for patients who had spontaneous delivery. Table 15 presents the detailed episiotomy rate distribution across hospitals between 2003 and 2008 for the same patient group. The mean episiotomy rates (in the first column of Table 15) for patients who had spontaneous delivery declined by eight percentage points (from 41% in 2003 to 33% in 2008). The box-and-whisker plot and the interquartile ranges (in the last column of Table 15) show that the variance of episiotomy rate has only narrowed slightly, and there remained substantial variation.

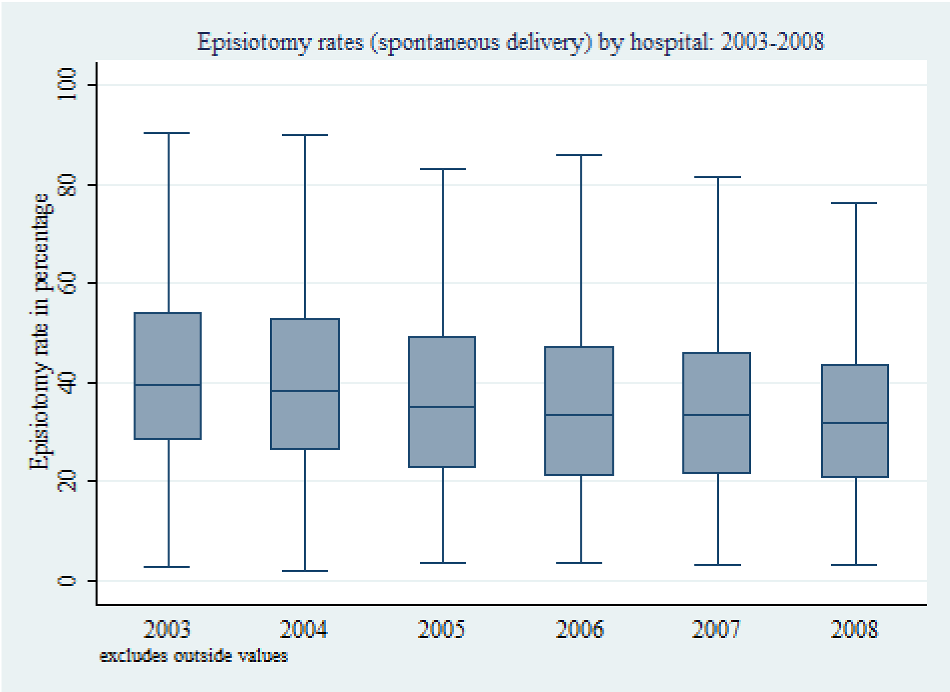


Figure 8. Variances of practice patterns (in episiotomy rate) for spontaneous delivery between 2003 and 2008

Table 15. Practice variation (in episiotomy rates) for spontaneous delivery between 2003 and 2008 by percentiles

	Mean (%)	SD (%)	Percentiles (%) 5th	25th	75th	95th	Interquartile range (%)
State Inpatient Discharge Data: 663 Hospitals*							
2003	41.37	17.98	14.29	28.18	54.21	72.77	26.02
2004	40.05	17.90	14.03	26.17	52.94	71.74	26.77
2005	36.80	17.54	11.63	22.58	49.33	69.89	26.75
2006	35.16	17.50	9.73	21.10	47.22	66.22	26.12
2007	34.43	16.99	9.90	21.43	45.89	66.67	24.46
2008	33.04	16.36	9.42	20.69	43.51	61.90	22.82

Notes: Exclude hospitals with less than ten episiotomy patients in a year between 2003 and 2008.

2. Operative Delivery

Figure 9 displays variances of episiotomy practice patterns across 335 (37% of initial 897) hospitals between 2003 and 2008, in number of episiotomies, for patients who had operative delivery. 562 hospitals, with less than ten patients in a year between 2003 and 2008, are dropped. Table 16 presents the practice variations across hospitals between 2003 and 2008, in number of episiotomies, by percentiles for the same patient group.

The box-and-whisker plot shows that the overall trend in episiotomy volume variances narrowed between 2003 and 2008. The average hospital episiotomy volume (in the first column of Table 16) for operative delivery is also declining. The interquartile ranges (in the last column of Table 16) show that the interquartile of episiotomy volume has narrowed from 26 to 17 between 2003 and 2008.

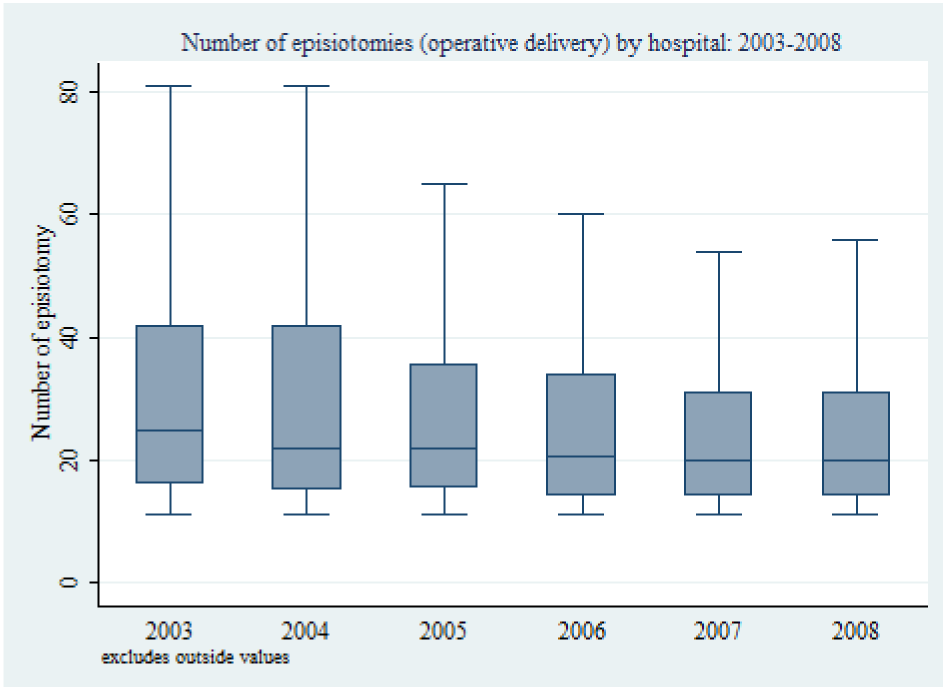


Figure 9. Variances of practice patterns (in number of episiotomies) for operative delivery between 2003 and 2008

Table 16. Practice variation (in number of episiotomies) for operative delivery between 2003 and 2008 by percentiles

			Percentiles				Interquartile
	Mean	**SD**	**5th**	**25th**	**75th**	**95th**	**range**
State Inpatient Discharge Data: 335 Hospitals*							
2003	35.12	30.67	11.00	16.00	42.00	99.00	26.00
2004	33.21	29.22	11.00	15.00	42.00	90.00	27.00
2005	31.25	26.76	11.00	15.50	35.50	90.00	20.00
2006	29.57	28.21	11.00	14.00	34.00	73.00	20.00
2007	27.81	24.96	11.00	14.00	31.00	68.00	17.00
2008	26.99	22.19	11.00	14.00	31.00	67.00	17.00

Notes: Exclude hospitals with less than ten episiotomy patients in a year between 2003 and 2008.

Figure 10 displays variances of episiotomy practice patterns across hospitals between 2003 and 2008, in episiotomy rates, for patients who had operative delivery. Table 17 presents the detailed distribution of the practice variations across hospitals between 2003 and 2008, in episiotomy rates for the same patient group.

Unlike the case of spontaneous delivery, there is no evidence of narrowing variance in episiotomy rate for operative delivery. However, the first column of Table 17 shows a decline in the mean episiotomy rates for patients who had operative delivery. The last column of Table 17 shows the interquartile ranges remain constant at 23% before widening to 28% in 2008.

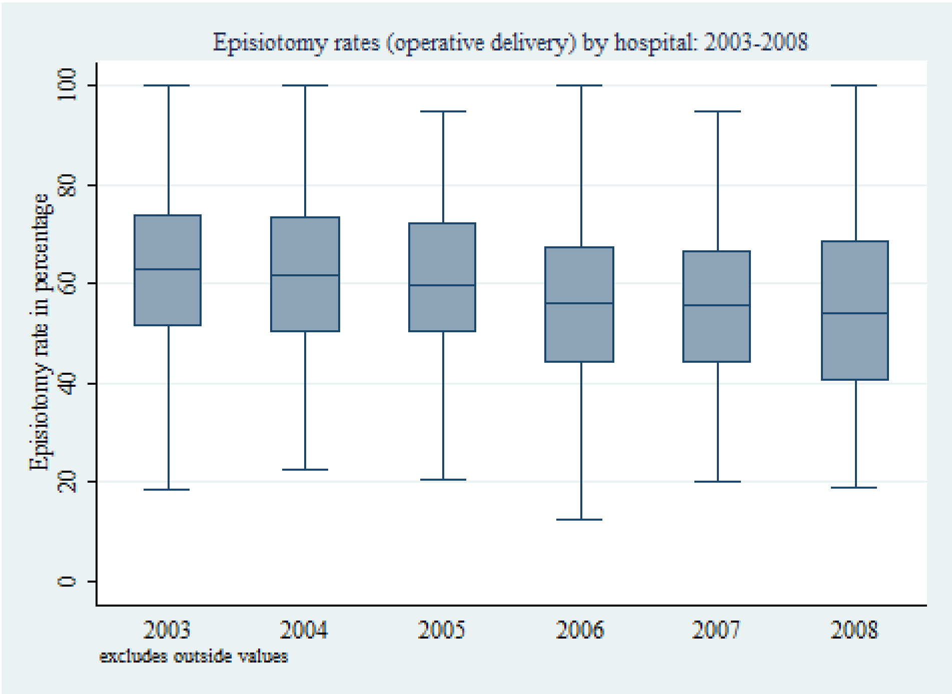


Figure 10. Variances of practice patterns (in episiotomy rate) for operative delivery between 2003 and 2008

Table 17. Practice variation (in episiotomy rates) for operative delivery between 2003 and 2008 by percentiles

	Mean (%)	SD (%)	Percentiles (%) 5th	25th	75th	95th	Interquartile range (%)
State Inpatient Discharge Data: 335 Hospitals*							
2003	62.57	17.11	32.29	51.19	73.74	90.00	22.55
2004	61.65	17.03	33.70	50.00	73.33	87.50	23.33
2005	60.86	17.21	31.88	50.00	72.36	89.66	22.36
2006	56.64	17.77	27.66	43.88	67.33	90.00	23.45
2007	55.76	17.36	25.53	44.00	66.67	85.71	22.67
2008	55.54	18.69	24.59	40.48	68.75	86.67	28.27

Notes: Exclude hospitals with less than ten episiotomy patients in a year between 2003 and 2008.

D. SUMMARY

Overall, all multivariate models show that episiotomy rates have decreased over the years, and downward trends for episiotomy rates, accelerate marginally by approximately two percentage points after release of the JAMA study, and such effects are statistically significant for spontaneous deliveries. This effect appears to be larger for bigger hospitals.[82] Hospitals do not also appear to respond differentially to release of the JAMA publication for most dimensions of hospital characteristics, except for hospital size, maternity ward turnover and ownership structure (proxy for provider type). As shown in Table 10, the interaction terms suggest that hospitals, which handle more births than average have a steeper decline in episiotomy rates after the JAMA publication. For operative deliveries, women who deliver in hospitals which handle 1,000 more births per bassinets per year, after release of the JAMA study, are less likely by 24 percentage points to receive episiotomy. The random effects regression results (in Table 12) also show that for all three patient cohorts, women delivering in government hospitals are more likely by 2–3 percentage points to receive episiotomy.

With regard to hospital characteristics, depending on patient cohorts, hospital size, maternity ward turnover, and hospital ownership have varying degrees of effect on episiotomy rates. The results (in Table 12) show that women who deliver in hospitals whose annual birth volume is 1,000 above the average are more likely by about one

[82] See Tables 11 and 13.

percentage point to receive episiotomy. When restricting sample to just operative deliveries, episiotomy rate for women who deliver in hospitals which handle 1,000 more births is predicted to increase by 18 percentage points. For spontaneous deliveries, women who deliver in government hospitals are six percentage points less likely to receive episiotomy, compared to those who deliver in not-for-profit hospitals. Episiotomy rate for women who have operative delivery in for-profit hospitals is estimated to increase by three percentage points, compared to those who deliver in not-for-profit hospitals.

The analysis of variation in practice patterns by patient volume (in Tables 14 and 16) generally shows that episiotomy volumes, for both spontaneous and operative deliveries, are declining and suggests that practice variations by volume for both patient cohorts are decreasing between 2003 and 2008. For spontaneous deliveries, the mean number of episiotomies across 663 hospitals drops from 70 to 50 patients per year. For operative deliveries, the mean drops from 35 to 27 patients per year between 2003 and 2008.

The analysis of practice variation by episiotomy rates suggests different results for the two patient cohorts. For spontaneous deliveries, the mean episiotomy rates declined by eight percentage points but the box-and-whisker plot (in Figure 8) and interquartile ranges (in Table 15) suggests that the variance of episiotomy rates has only narrowed slightly and there remained substantial variation. Unlike the case of spontaneous deliveries, there is no evidence of narrowing variance in episiotomy rates for operative deliveries. The interquartile ranges (in Table 17) remain constant at 23% before widening to 28% in 2008.

The discussion on these findings will be presented in Chapter VI. Chapter VI will also provide conclusions for this research and recommendations for future studies.

VI. CONCLUSIONS AND RECOMMENDATIONS

Indeed, the true value of any comparative effectiveness research lies in its impact on practice patterns following these publications. It is important for practitioners, in general, to constantly remain abreast of the latest evidence-based research and adopt, in their clinical practices, recommendations beneficial to the well-being of their patients. The Patient Protection and Affordable Care Act of 2010 has set aside funding for comparative effectiveness studies[83], with the rationale that such study would be an effective tool in reducing health care cost by identifying ineffective procedures. This thesis examines whether a release of such study indeed lead to decrease in use of ineffective procedure in the case of episiotomy, and provides empirical evidence to demonstrate or disprove claims that findings from Hartmann et al.'s study have led to further declines in practices of episiotomy.

The declining trends for episiotomy rates accelerate marginally, after release of the JAMA study, by approximately two percentage points. This effect appears to be larger for bigger hospitals. Lappen and Gosette listed "lack of awareness or familiarity with current recommendations" as one of the many reasons why obstetricians fail to follow guidelines.[84] Adoption of research evidence could therefore be conceivably slow among obstetricians and the true effect of Hartmann et al.'s study on episiotomy practices might therefore take another few years to actualize. Another possible explanation for the small impact of the JAMA publication is that episiotomy practices might have already been influenced heavily by publications prior to release of the JAMA study.

Hospitals do not appear to respond differentially to the JAMA publication for most dimensions of hospital characteristics, except for hospital size, maternity ward

[83] U.S. General Accountability Office, *HHS Research Awards: Use of Recovery Act and Patient Protection and Affordable Care Act Funds for Comparative Effectiveness Research*, (GAO-11-712R), Washington, DC: GAO, 2011. http://www.gao.gov/new.items/d11712r.pdf (accessed November 10, 2011).

[84] Justin R. Lappen and Dana R. Gossett, "Changes in episiotomy practice," 304.

capacity and ownership structure (proxy for provider type). Teaching hospitals and level of specialization in obstetric care also do not appear to have statistically significant effect on episiotomy rates.

According to Webb and Culhane, practitioners are also more inclined to perform episiotomy when patient demands are higher, as a way to facilitate the delivery.[85] Our hypothesis that the JAMA publication is less likely to lower episiotomy rate appears to be proven wrong. Larger hospitals (proxied by number of births in 1,000s and normalized) appear to have bigger responses to release of the JAMA publication. The marginal effect is larger when restricting the samples to only hospitals that handled at least 25 deliveries per year between 2003 and 2008. In addition, the interaction terms indicate that hospitals with above average number of births have a steeper decline in episiotomy rates after release of the JAMA publication. For example, a hospital whose annual birth volume is 1,000 above the average saw a steeper decline in overall episiotomy rate by 0.6 percentage point. Clinicians could also be systematically different in larger and busier hospitals. Greater peer influences and more effective knowledge management strategies in larger hospitals might have contributed to a faster adoption rate of research evidence in clinical practices.

Lappen and Gosette highlighted that provider type is one of the most important factors that might affect episiotomy rates.[86] The regression model results show consistent evidence that hospitals with different ownership structure have different episiotomy rates. Among operative deliveries, women delivering in for-profit hospitals are more likely by 3–4 percentage points to receive episiotomy, compared to those delivering in not-for-profit hospitals. Among spontaneous deliveries, women delivering in government hospitals are less likely to undergo episiotomy, compared to those delivering in not-for-profit hospitals. Clinicians in for-profit hospitals might behave differently from clinicians in other hospitals due to possible differences in incentives. It is also possible that patients in for-profit hospitals systematically differ from patients in other hospitals in a way that their clinical presentations indicate higher likelihood to

[85] David A. Webb and Jennifer F Culhane, “Time of day variation,” 577.

[86] Justin R. Lappen and Dana R. Gossett, “Changes in episiotomy practice,” 304.

receive episiotomy and those characteristics are not captured in the models. It would be interesting to explore in future research if clinicians and patients are indeed systematically different across hospital types.

According to Robinson et al.[87] and Howden et al.[88], private clinicians are more likely to perform episiotomies on their patients, compared to faculty practitioners. However, the results show no evidence that cultural differences (as proxied by teaching hospitals) among hospitals and the level of obstetric services offered by hospitals have any statistically significant impacts on episiotomy rates. Factors such as staff composition (i.e., obstetricians and midwives), average experience level of clinicians and revenue sharing arrangements might have shaped cultures differently across teaching hospitals and hospitals offering the same level of obstetric services. However, this information is not available at the point of this study. Future research is therefore recommended if the data is made available for research.

The data shows that episiotomy rates vary substantially depending on patients' insurance status and race. The regression results confirm that the demographic composition of patients delivering in a hospital is predicted to have statistically significant effects on the use of episiotomy of the same hospital. While it is important to control for demographic compositions of the patients in the regressions to account for traits of these demographic characteristics, interpretation of the regression results at the hospital level might not be intuitive and is not likely to have practical implications for management of the hospital operations. Therefore, patient-level analyses are recommended for future research to determine practical and meaningful effects of these demographic characteristics to both practitioners and patients.

The analysis of variation in practice patterns suggests that practice variations by episiotomy volumes for both spontaneous and operative deliveries, are declining between 2003 and 2008. However, variances of episiotomy rates for spontaneous deliveries remain substantial and there is no evidence of narrowing variance in episiotomy rate for

[87] Julian N. Robinson et al., "Predictors of Episiotomy Use," 216.

[88] Nancy L. S. Howden et al., "Episiotomy Use Among Residents and Faculty," 116.

operative deliveries. The narrowing practice variations by episiotomy volumes reflect the overall decline in episiotomy patients. This suggests that clinical practices among obstetric clinicians might not have truly changed. There remains more work to be done to bring about a change in clinical practices and in turn, a decline in episiotomy rates.

It is important to note that this research is only representative of populations having demographic distributions similar to that of the eight states. Both Hispanic and other races are overly represented in the eight states and are therefore not nationally representative. However, the female age distribution of the eight states is close and to some extent, represents well of the female population in the United States. The distribution of the hospital characteristics also differs from that at the national level. The eight states have a greater proportion of not-for-profit and teaching hospitals. The average number of births handled by the hospitals is also higher in the eight states. If data is made available in future, future research is recommended to determine the impact of similar comparative effectiveness studies on episiotomy.

To determine the effects of provider type and patient demand on episiotomy rates, we argue that it is reasonable although not perfect to use hospital ownership and maternity ward turnover as proxies. In addition, the fixed-effects models control for underlying patient and hospital characteristics differences. To the extent that patient composition change coincides with the timing of JAMA publication (although chance of that is slim), the JAMA publication effect would be biased.

Hartmann et al. advocated that "rates of episiotomy of less than 15% of spontaneous vaginal births should be immediately within reach."[89] The data show that episiotomy rate for spontaneous delivery is gradually declining towards 15%, but even by the end of 2008, over 30% of those covered by private insurance are still receiving this procedure. Both the data and regression results show that patients who have operative delivery are more likely to undergo episiotomy by 10–13 percentage points, compared to those who have spontaneous delivery. It is also interesting that even after controlling for patient demographics and hospital characteristics, patients covered by private insurance

[89] Katherine Hartmann et al., "Outcomes of Routine Episiotomy," 2147.

have a much higher rate of receiving episiotomy compared to those covered by Medicaid and uninsured. Similarly, financial incentives facing the physicians might also explain why for-profit hospitals have a higher rate than others. While the data does not provide enough details to explore this financial aspect, it would be important to explore in future studies whether and how payment arrangements in private insurance contribute to such a gap in episiotomy rate.

To bridge the gap between research evidences and clinical practices on episiotomy, more effective strategies should be formulated to reach out to different audiences. Nonprofit organizations such as ACOG could organize more seminars and workshops to inform a wider group of obstetric practitioners the latest medical related evidence-based research and its guidelines for adoption of these research findings. Hospital managements should encourage their staff to attend these events to keep their practices abreast of the latest developments in the field of obstetrics and gynecology. It is also equally important to reach out and educate patients the benefits and harms of episiotomy. By empowering patients with the necessary knowledge, patients might be able to positively influence their obstetricians to adopt a more restrictive episiotomy policy.

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APPENDIX A. RESULTS FOR FIXED EFFECTS REGRESSIONS ON EPISIOTOMY RATES WITH CONTROLS FOR NORMALIZED BIRTH SIZES AND HOSPITAL CAPACITY

Table 18. Multivariate results (fixed effects with additional controls for normalized births and hospital capacity, hospitals with at least one delivery per year between 2003 and 2008)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
JAMA dummy	-2.13**	-2.60***	-1.91	-0.06	-1.87**	-1.13
(1 if date > 2005 qtr 2)	(0.83)	(0.93)	(1.45)	(1.63)	(0.86)	(0.97)
Delivery Type					12.23***	12.23***
(1 if Operative)					(0.64)	(0.64)
Interaction Terms						
JAMA x normalized births	-0.32*	-0.38**	-0.83***	-0.58*	-0.55***	-0.45**
	(0.18)	(0.17)	(0.31)	(0.32)	(0.20)	(0.21)
JAMA x births (in '000)		5.94		-23.62***		-9.40*
per year per bassinet		(5.25)		(8.56)		(5.37)
JAMA x for-profit hospitals	1.22	1.11	1.14	1.59	0.91	1.09
	(0.99)	(1.01)	(1.71)	(1.74)	(1.15)	(1.17)
JAMA x government	1.45	1.35	1.51	1.90	1.39	1.54*
hospitals	(0.92)	(0.93)	(1.31)	(1.32)	(0.89)	(0.90)
JAMA x teaching hospitals	-0.55	-0.51	0.20	0.06	-0.41	-0.46
	(0.82)	(0.81)	(1.56)	(1.56)	(0.95)	(0.95)
JAMA x obstetric level 1	-0.94	-0.93	-0.59	-0.62	-0.88	-0.89
	(0.75)	(0.75)	(1.15)	(1.15)	(0.76)	(0.76)
JAMA x obstetric level 2	-0.58	-0.66	-0.61	-0.30	-0.70	-0.58
	(0.70)	(0.71)	(1.21)	(1.22)	(0.76)	(0.77)
JAMA x obstetric level 3	1.00	0.96	0.37	0.50	0.71	0.76
	(0.76)	(0.76)	(1.44)	(1.44)	(0.86)	(0.86)
Hospital Characteristics						
Normalized births ((births –	0.31	0.30	0.87	0.84	0.57	0.53
mean(births)) / 1,000)	(0.29)	(0.31)	(0.55)	(0.60)	(0.37)	(0.39)
Births (in '000) per year		-1.85		10.69		5.35
per bassinet		(6.29)		(11.03)		(6.98)
Patient Composition						
Percent (self-pay/no charge)	5.54***	5.55***	24.86***	24.85***	22.22***	22.22***
	(1.89)	(1.90)	(2.57)	(2.57)	(1.92)	(1.92)
Percent (private insurance)	10.32***	10.31***	29.38***	29.43***	28.09***	28.11***
	(1.48)	(1.48)	(1.70)	(1.69)	(1.31)	(1.31)
Percent (age 25 - 29)	-2.25*	-2.24*	8.71***	8.69***	8.67***	8.65***
	(1.31)	(1.32)	(1.65)	(1.65)	(1.20)	(1.20)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
Percent (age 30 - 34)	-2.23	-2.22	3.49**	3.45**	5.38***	5.36***
	(1.40)	(1.40)	(1.74)	(1.74)	(1.31)	(1.31)
Percent (age 35 and above)	-6.33*	-6.35*	3.02	3.02	3.71*	3.71*
	(3.67)	(3.67)	(2.27)	(2.26)	(1.92)	(1.92)
Percent (black)	-10.45***	-10.47***	15.61***	15.66***	10.93***	10.95***
	(2.39)	(2.40)	(2.86)	(2.86)	(2.09)	(2.09)
Percent (hispanic)	-1.33	-1.40	24.00***	24.06***	18.24***	18.27***
	(1.65)	(1.65)	(1.95)	(1.95)	(1.61)	(1.61)
Percent (other races)	7.45***	7.47***	18.81***	18.80***	17.47***	17.46***
	(1.99)	(1.99)	(2.16)	(2.16)	(1.93)	(1.93)
Percent (unknown races)	2.71*	2.71*	22.03***	22.03***	14.59***	14.59***
	(1.62)	(1.62)	(2.37)	(2.37)	(1.50)	(1.50)
Year and Quarter Dummies						
2004	-1.50***	-1.49***	-1.54**	-1.58**	-1.55***	-1.57***
	(0.42)	(0.42)	(0.74)	(0.74)	(0.43)	(0.44)
2005	-2.38***	-2.37***	-1.44	-1.51	-1.94***	-1.97***
	(0.67)	(0.67)	(1.22)	(1.23)	(0.70)	(0.70)
2006	-4.30***	-4.29***	-4.50***	-4.55***	-4.49***	-4.52***
	(0.79)	(0.79)	(1.46)	(1.46)	(0.85)	(0.85)
2007	-6.01***	-6.00***	-5.26***	-5.33***	-5.78***	-5.82***
	(0.81)	(0.82)	(1.47)	(1.47)	(0.86)	(0.86)
2008	-7.08***	-7.07***	-5.90***	-5.95***	-6.59***	-6.62***
	(0.81)	(0.81)	(1.47)	(1.48)	(0.86)	(0.86)
Quarter 2	-0.16	-0.16	-0.21	-0.21	-0.23	-0.23
	(0.26)	(0.26)	(0.62)	(0.62)	(0.34)	(0.34)
Quarter 3	-0.89***	-0.89***	-0.58	-0.58	-0.74**	-0.75**
	(0.29)	(0.29)	(0.61)	(0.61)	(0.35)	(0.35)
Quarter 4	-1.24***	-1.24***	-0.07	-0.07	-0.54	-0.54
	(0.29)	(0.29)	(0.67)	(0.67)	(0.38)	(0.38)
Constant	30.12***	30.28***	14.92***	14.04***	5.24***	4.80***
	(1.23)	(1.31)	(0.93)	(1.25)	(0.92)	(1.05)
Observations	16,104	16,104	16,104	16,104	32,208	32,208
R-squared	0.095	0.095	0.224	0.225	0.215	0.215
Number of hospitals	671	671	671	671	671	671

Notes: Robust standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 19. Multivariate results (fixed effects with additional controls for normalized births and hospital capacity, hospitals with at least 25 deliveries per year between 2003 and 2008)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
JAMA dummy	-2.30***	-2.74***	-0.89	1.02	-1.59*	-0.76
(1 if date > 2005 qtr 2)	(0.68)	(0.81)	(1.72)	(1.94)	(0.92)	(1.06)
Delivery Type					13.46***	13.46***
(1 if Operative)					(0.70)	(0.70)
Interaction Terms						
JAMA x normalized births	-0.24	-0.29	-0.75**	-0.54	-0.47**	-0.37*
	(0.18)	(0.18)	(0.35)	(0.35)	(0.22)	(0.22)
JAMA x births (in '000)		5.23		-22.91**		-10.04*
per year per bassinet		(5.42)		(9.56)		(5.95)
JAMA x for-profit	1.19	1.11	0.40	0.79	0.52	0.71
hospitals	(0.97)	(0.99)	(1.83)	(1.86)	(1.19)	(1.21)
JAMA x government	1.32	1.20	2.10	2.66	1.50	1.75
hospitals	(0.92)	(0.94)	(1.71)	(1.76)	(1.09)	(1.12)
JAMA x teaching	-0.01	0.03	-0.58	-0.74	-0.41	-0.47
hospitals	(0.83)	(0.83)	(1.67)	(1.68)	(1.03)	(1.03)
JAMA x obstetric level 1	-0.30	-0.30	-1.45	-1.42	-1.04	-1.02
	(0.78)	(0.78)	(1.51)	(1.51)	(0.93)	(0.93)
JAMA x obstetric level 2	-0.35	-0.42	-0.61	-0.32	-0.59	-0.47
	(0.66)	(0.67)	(1.39)	(1.40)	(0.82)	(0.83)
JAMA x obstetric level 3	0.64	0.63	0.43	0.51	0.57	0.61
	(0.72)	(0.73)	(1.57)	(1.56)	(0.91)	(0.91)
Hospital Characteristics						
Normalized births ((births	0.30	0.28	0.67	0.55	0.46	0.36
– mean(births)) / 1,000)	(0.31)	(0.34)	(0.57)	(0.61)	(0.38)	(0.41)
Births (in '000) per year		-1.07		14.83		8.60
per bassinet		(6.76)		(11.77)		(7.41)
Patient Composition						
Percent (self-pay/no	3.57**	3.58**	23.53***	23.51***	21.87***	21.88***
charge)	(1.61)	(1.61)	(2.61)	(2.60)	(2.15)	(2.15)
Percent (private insurance)	10.26***	10.24***	27.42***	27.47***	27.65***	27.68***
	(1.57)	(1.57)	(1.79)	(1.79)	(1.50)	(1.50)
Percent (age 25 - 29)	-3.86***	-3.85***	7.64***	7.63***	8.30***	8.29***
	(1.47)	(1.47)	(1.81)	(1.81)	(1.50)	(1.50)
Percent (age 30 - 34)	-3.40**	-3.40**	3.25*	3.21*	5.40***	5.38***
	(1.66)	(1.65)	(1.89)	(1.89)	(1.58)	(1.58)
Percent (age 35 and	-6.07	-6.14	3.43	3.42	2.57	2.57
above)	(4.10)	(4.10)	(2.48)	(2.47)	(2.23)	(2.22)
Percent (black)	-12.36***	-12.37***	16.14***	16.17***	12.25***	12.25***
	(2.34)	(2.34)	(3.05)	(3.05)	(2.38)	(2.38)
Percent (hispanic)	-0.46	-0.53	24.55***	24.63***	20.72***	20.76***
	(2.34)	(2.34)	(2.06)	(2.06)	(1.79)	(1.79)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
Percent (other races)	8.88***	8.90***	19.69***	19.69***	19.14***	19.13***
	(2.43)	(2.43)	(2.28)	(2.28)	(2.20)	(2.20)
Percent (unknown races)	0.23	0.26	22.66***	22.67***	18.61***	18.61***
	(2.50)	(2.50)	(2.62)	(2.62)	(1.87)	(1.87)
Year and Quarter Dummies						
2004	-1.25***	-1.25***	-2.30***	-2.35***	-1.80***	-1.82***
	(0.39)	(0.39)	(0.85)	(0.85)	(0.48)	(0.48)
2005	-2.33***	-2.32***	-2.28	-2.38	-2.13***	-2.18***
	(0.61)	(0.62)	(1.46)	(1.46)	(0.79)	(0.80)
2006	-4.30***	-4.30***	-5.83***	-5.94***	-4.95***	-5.01***
	(0.69)	(0.69)	(1.69)	(1.69)	(0.92)	(0.92)
2007	-5.81***	-5.80***	-6.69***	-6.81***	-6.22***	-6.28***
	(0.74)	(0.74)	(1.73)	(1.74)	(0.96)	(0.97)
2008	-7.21***	-7.20***	-7.89***	-8.00***	-7.36***	-7.43***
	(0.77)	(0.78)	(1.71)	(1.72)	(0.95)	(0.96)
Quarter 2	0.11	0.11	-0.07	-0.07	0.05	0.05
	(0.24)	(0.24)	(0.71)	(0.71)	(0.38)	(0.38)
Quarter 3	-0.88***	-0.87***	-0.33	-0.33	-0.51	-0.51
	(0.25)	(0.25)	(0.70)	(0.70)	(0.38)	(0.38)
Quarter 4	-1.21***	-1.21***	0.22	0.22	-0.40	-0.40
	(0.25)	(0.25)	(0.79)	(0.79)	(0.42)	(0.42)
Constant	33.20***	33.33***	17.56***	16.25***	5.18***	4.44***
	(1.89)	(1.90)	(1.15)	(1.50)	(1.10)	(1.25)
Observations	12,816	12,816	12,816	12,816	25,632	25,632
R-squared	0.134	0.134	0.211	0.211	0.226	0.226
Number of hospitals	534	534	534	534	534	534

Notes: Robust standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

APPENDIX B. RESULTS FOR RANDOM EFFECTS REGRESSIONS ON EPISIOTOMY RATES WITH CONTROLS FOR NORMALIZED BIRTH SIZES AND HOSPITAL CAPACITY

Table 20. Multivariate results (random effects with additional controls for normalized births and hospital capacity, hospitals with at least one delivery per year between 2003 and 2008)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
JAMA dummy	-2.21**	-2.61***	-2.13	-0.17	-2.06**	-1.27
(1 if date > 2005 qtr 2)	(0.93)	(1.00)	(1.54)	(1.70)	(0.93)	(1.02)
Delivery Type					12.28***	12.29***
(1 if Operative)					(0.64)	(0.64)
Interaction Terms						
JAMA x normalized births	-0.25	-0.31*	-0.82**	-0.54	-0.50**	-0.39*
	(0.18)	(0.18)	(0.33)	(0.33)	(0.21)	(0.21)
JAMA x births (in '000)		5.19		-25.64***		-10.40*
per year per bassinet		(5.23)		(8.64)		(5.35)
JAMA x for-profit hospitals	1.41	1.30	1.21	1.75	1.07	1.28
	(1.04)	(1.06)	(1.73)	(1.76)	(1.18)	(1.20)
JAMA x government	1.96**	1.86*	2.26	2.75*	2.08**	2.29**
hospitals	(0.98)	(0.99)	(1.39)	(1.42)	(0.95)	(0.96)
JAMA x teaching hospitals	-0.93	-0.90	-0.01	-0.15	-0.72	-0.78
	(0.88)	(0.88)	(1.59)	(1.60)	(0.99)	(0.99)
JAMA x obstetric level 1	-0.56	-0.55	-0.25	-0.28	-0.46	-0.48
	(0.99)	(0.99)	(1.38)	(1.38)	(0.95)	(0.95)
JAMA x obstetric level 2	-0.86	-0.95	-0.94	-0.51	-1.00	-0.82
	(0.88)	(0.89)	(1.46)	(1.46)	(0.93)	(0.93)
JAMA x obstetric level 3	0.99	0.95	0.78	0.98	1.02	1.11
	(0.96)	(0.97)	(1.67)	(1.67)	(1.07)	(1.08)
Hospital Characteristics						
Normalized births ((births –	0.67**	0.70**	1.13***	0.92**	0.82**	0.77**
mean(births)) / 1,000)	(0.28)	(0.30)	(0.41)	(0.42)	(0.32)	(0.33)
Births (in '000) per year		-3.26		18.12**		5.55
per bassinet		(6.19)		(8.71)		(6.26)
For-profit hospitals	0.95	1.01	3.35*	2.97*	2.75*	2.63*
	(1.42)	(1.43)	(1.76)	(1.77)	(1.51)	(1.52)
Government hospitals	-5.77***	-5.67***	-2.63*	-3.01*	-4.78***	-4.93***
	(1.59)	(1.60)	(1.57)	(1.57)	(1.41)	(1.41)
Teaching hospitals	-0.59	-0.60	-3.40*	-3.31	-2.46	-2.45
	(1.36)	(1.36)	(2.02)	(2.02)	(1.64)	(1.65)
Obstetric level 1	-0.82	-0.84	-0.76	-0.69	-0.69	-0.66
	(0.95)	(0.95)	(1.33)	(1.32)	(0.93)	(0.93)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
Obstetric level 2	0.69	0.73	0.23	-0.01	0.45	0.37
	(0.88)	(0.88)	(1.36)	(1.36)	(0.94)	(0.94)
Obstetric level 3	-0.34	-0.32	-1.71	-1.80	-1.23	-1.28
	(0.92)	(0.93)	(1.64)	(1.63)	(1.09)	(1.09)
Patient Composition						
Percent (self-pay/no charge)	5.92***	5.91***	25.73***	25.75***	22.43***	22.43***
	(1.84)	(1.84)	(2.55)	(2.54)	(1.91)	(1.91)
Percent (private insurance)	11.18***	11.17***	29.41***	29.46***	28.03***	28.04***
	(1.43)	(1.43)	(1.63)	(1.63)	(1.28)	(1.28)
Percent (age 25 - 29)	-2.09	-2.08	9.83***	9.79***	8.99***	8.98***
	(1.32)	(1.32)	(1.64)	(1.64)	(1.19)	(1.19)
Percent (age 30 - 34)	-1.45	-1.45	4.46***	4.40**	5.83***	5.81***
	(1.40)	(1.40)	(1.72)	(1.72)	(1.30)	(1.30)
Percent (age 35 and above)	-5.59	-5.61	3.48	3.46	4.09**	4.09**
	(3.67)	(3.67)	(2.25)	(2.25)	(1.92)	(1.92)
Percent (black)	-9.94***	-9.95***	17.30***	17.34***	11.17***	11.19***
	(2.16)	(2.16)	(2.77)	(2.77)	(2.02)	(2.02)
Percent (hispanic)	-0.24	-0.28	26.44***	26.48***	18.94***	18.98***
	(1.49)	(1.49)	(1.80)	(1.80)	(1.54)	(1.54)
Percent (other races)	8.64***	8.66***	20.71***	20.69***	18.10***	18.09***
	(1.97)	(1.97)	(2.14)	(2.14)	(1.93)	(1.92)
Percent (unknown races)	1.17	1.16	18.96***	18.98***	13.15***	13.16***
	(1.51)	(1.51)	(2.35)	(2.35)	(1.47)	(1.47)
Year and Quarter Dummies						
2004	-1.49***	-1.48***	-1.50**	-1.56**	-1.54***	-1.56***
	(0.41)	(0.41)	(0.74)	(0.74)	(0.43)	(0.43)
2005	-2.37***	-2.34***	-1.37	-1.49	-1.92***	-1.96***
	(0.67)	(0.67)	(1.22)	(1.23)	(0.70)	(0.70)
2006	-4.26***	-4.24***	-4.41***	-4.52***	-4.45***	-4.48***
	(0.79)	(0.79)	(1.46)	(1.46)	(0.84)	(0.85)
2007	-5.92***	-5.90***	-5.07***	-5.20***	-5.66***	-5.70***
	(0.82)	(0.82)	(1.46)	(1.46)	(0.86)	(0.86)
2008	-7.05***	-7.03***	-5.66***	-5.77***	-6.48***	-6.51***
	(0.81)	(0.81)	(1.47)	(1.47)	(0.85)	(0.85)
Quarter 2	-0.18	-0.18	-0.16	-0.16	-0.23	-0.23
	(0.26)	(0.26)	(0.62)	(0.62)	(0.34)	(0.34)
Quarter 3	-0.91***	-0.91***	-0.63	-0.63	-0.76**	-0.76**
	(0.29)	(0.29)	(0.61)	(0.61)	(0.35)	(0.35)
Quarter 4	-1.25***	-1.25***	-0.09	-0.09	-0.56	-0.56
	(0.29)	(0.29)	(0.68)	(0.68)	(0.38)	(0.38)
Constant	30.12***	30.36***	14.75***	13.45***	5.88***	5.49***
	(1.50)	(1.56)	(1.30)	(1.45)	(1.10)	(1.20)
Observations	16,104	16,104	16,104	16,104	32,208	32,208
Number of hospitals	671	671	671	671	671	671

Notes: Robust standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 21. Multivariate results (random effects with additional controls for normalized births and hospital capacity, hospitals with at least 25 deliveries per year between 2003 and 2008)

VARIABLES	Spontaneous delivery without control for maternity ward turnover epi_rate	Spontaneous delivery with control for maternity ward turnover epi_rate	Operative delivery without control for maternity ward turnover epi_rate	Operative delivery with control for maternity ward turnover epi_rate	Both delivery types without control for maternity ward turnover epi_rate	Both delivery types with control for maternity ward turnover epi_rate
JAMA dummy	-2.53***	-2.90***	-0.94	1.06	-1.72*	-0.81
(1 if date > 2005 qtr 2)	(0.78)	(0.86)	(1.84)	(2.03)	(0.99)	(1.11)
Delivery Type					13.46***	13.47***
(1 if Operative)					(0.70)	(0.70)
Interaction Terms						
JAMA x normalized births	-0.20	-0.24	-0.72**	-0.49	-0.42*	-0.32
	(0.18)	(0.18)	(0.36)	(0.36)	(0.23)	(0.23)
JAMA x births (in '000)		4.62		-24.69**		-11.17*
per year per bassinet		(5.36)		(9.70)		(5.94)
JAMA x for-profit hospitals	1.25	1.17	0.23	0.67	0.53	0.73
	(1.03)	(1.05)	(1.87)	(1.90)	(1.23)	(1.24)
JAMA x government	1.94**	1.81*	3.03*	3.75**	2.41**	2.74**
hospitals	(0.98)	(1.02)	(1.83)	(1.91)	(1.17)	(1.22)
JAMA x teaching hospitals	-0.40	-0.36	-0.46	-0.66	-0.57	-0.66
	(0.92)	(0.92)	(1.72)	(1.73)	(1.08)	(1.08)
JAMA x obstetric level 1	0.44	0.44	-1.08	-1.06	-0.55	-0.54
	(1.02)	(1.02)	(1.80)	(1.80)	(1.14)	(1.15)
JAMA x obstetric level 2	-0.51	-0.59	-1.19	-0.78	-1.04	-0.85
	(0.84)	(0.85)	(1.68)	(1.69)	(1.01)	(1.02)
JAMA x obstetric level 3	0.82	0.79	0.18	0.34	0.58	0.65
	(0.95)	(0.95)	(1.85)	(1.85)	(1.16)	(1.16)
Hospital Characteristics						
Normalized births ((births –	0.36	0.36	0.60	0.43	0.45	0.38
mean(births)) / 1,000)	(0.28)	(0.31)	(0.43)	(0.44)	(0.34)	(0.35)
Births (in '000) per year		-2.15		18.11**		7.83
per bassinet		(6.49)		(9.19)		(6.57)
For-profit hospitals	0.17	0.19	3.57*	3.28*	2.59*	2.49
	(1.42)	(1.43)	(1.85)	(1.85)	(1.53)	(1.54)
Government hospitals	-5.04***	-4.92***	-1.70	-2.29	-4.56***	-4.85***
	(1.51)	(1.51)	(1.99)	(2.02)	(1.44)	(1.45)
Teaching hospitals	-0.24	-0.26	-3.43	-3.26	-2.83	-2.75
	(1.44)	(1.44)	(2.19)	(2.19)	(1.73)	(1.73)
Obstetric level 1	-1.41	-1.42	-0.50	-0.45	-0.76	-0.73
	(1.04)	(1.04)	(1.62)	(1.61)	(1.10)	(1.09)
Obstetric level 2	0.35	0.39	0.25	0.01	0.51	0.41
	(0.90)	(0.90)	(1.51)	(1.51)	(1.03)	(1.03)
Obstetric level 3	-0.53	-0.50	-0.61	-0.70	-0.65	-0.69
	(0.94)	(0.94)	(1.82)	(1.81)	(1.19)	(1.19)
Patient Composition						
Percent (self-pay/no charge)	3.82**	3.82**	23.96***	23.96***	21.92***	21.92***
	(1.58)	(1.58)	(2.58)	(2.57)	(2.14)	(2.14)

VARIABLES	**Spontaneous delivery without control for maternity ward turnover** epi_rate	**Spontaneous delivery with control for maternity ward turnover** epi_rate	**Operative delivery without control for maternity ward turnover** epi_rate	**Operative delivery with control for maternity ward turnover** epi_rate	**Both delivery types without control for maternity ward turnover** epi_rate	**Both delivery types with control for maternity ward turnover** epi_rate
Percent (private insurance)	11.16***	11.14***	27.27***	27.32***	27.51***	27.53***
	(1.51)	(1.51)	(1.72)	(1.72)	(1.46)	(1.46)
Percent (age 25 - 29)	-3.66**	-3.65**	8.60***	8.59***	8.62***	8.61***
	(1.46)	(1.46)	(1.80)	(1.80)	(1.50)	(1.50)
Percent (age 30 - 34)	-2.41	-2.40	4.18**	4.12**	5.89***	5.86***
	(1.63)	(1.63)	(1.87)	(1.87)	(1.57)	(1.57)
Percent (age 35 and above)	-5.26	-5.32	3.88	3.87	2.95	2.95
	(4.08)	(4.08)	(2.45)	(2.45)	(2.22)	(2.22)
Percent (black)	-12.36***	-12.37***	17.61***	17.65***	12.38***	12.40***
	(2.18)	(2.18)	(2.94)	(2.94)	(2.30)	(2.30)
Percent (hispanic)	0.09	0.03	26.60***	26.66***	21.13***	21.17***
	(2.14)	(2.14)	(1.89)	(1.89)	(1.72)	(1.72)
Percent (other races)	9.89***	9.91***	21.47***	21.46***	19.73***	19.71***
	(2.33)	(2.34)	(2.23)	(2.22)	(2.18)	(2.18)
Percent (unknown races)	-1.05	-1.04	19.24***	19.28***	16.62***	16.63***
	(2.27)	(2.27)	(2.60)	(2.59)	(1.84)	(1.84)
Year and Quarter Dummies						
2004	-1.23***	-1.22***	-2.29***	-2.34***	-1.80***	-1.82***
	(0.39)	(0.39)	(0.85)	(0.85)	(0.47)	(0.48)
2005	-2.30***	-2.29***	-2.23	-2.36	-2.13***	-2.19***
	(0.61)	(0.62)	(1.46)	(1.46)	(0.79)	(0.79)
2006	-4.19***	-4.17***	-5.75***	-5.88***	-4.90***	-4.96***
	(0.69)	(0.69)	(1.69)	(1.69)	(0.91)	(0.92)
2007	-5.65***	-5.63***	-6.53***	-6.66***	-6.09***	-6.14***
	(0.74)	(0.74)	(1.73)	(1.73)	(0.96)	(0.96)
2008	-7.09***	-7.07***	-7.67***	-7.80***	-7.24***	-7.30***
	(0.77)	(0.77)	(1.71)	(1.71)	(0.95)	(0.95)
Quarter 2	0.10	0.10	-0.03	-0.03	0.05	0.05
	(0.24)	(0.24)	(0.71)	(0.71)	(0.38)	(0.38)
Quarter 3	-0.88***	-0.88***	-0.36	-0.37	-0.53	-0.53
	(0.25)	(0.25)	(0.70)	(0.70)	(0.38)	(0.38)
Quarter 4	-1.21***	-1.21***	0.20	0.20	-0.42	-0.42
	(0.25)	(0.25)	(0.79)	(0.79)	(0.42)	(0.42)
Constant	33.28***	33.46***	17.01***	15.61***	5.78***	5.16***
	(2.04)	(2.03)	(1.52)	(1.66)	(1.25)	(1.34)
Observations	12,816	12,816	12,816	12,816	25,632	25,632
Number of hospitals	534	534	534	534	534	534

Notes: Robust standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%.

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