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Department of Economics
Working Paper

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November, 2006

Working Paper # - 2006-06

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Abstract: This paper examines the shift in childbirth from home to hospital that occurred in the United States in the early twentieth century. Using a panel of city-level data over the period 1927-1940, we examine the impact on maternal mortality resulting from the shift of childbirth from home to hospital. Results suggest that increased operative intervention on the part of physicians and a resultant greater risk of infection increased maternal mortality until the late 1930s. The introduction of sulfa drugs in 1937 enabled doctors to reduce maternal mortality by enabling them to do potentially life-saving procedures (such as cesareans) without the risk of subsequent infection. The advent of sulfa drugs combined with more judicious use of medical interventions by physicians helped reverse the impact of hospitals on maternal mortality in the late 1930s. Regressions estimated separately by race suggest that the impact of medical care on maternal mortality differed for blacks and whites. Relative to whites, hospitals posed a greater risk for black mothers prior to the late 1930s, and were less beneficial for them afterwards, suggesting that blacks may have received lower quality medical care.

*Thomasson is Associate Professor of Economics and Research Associate at the National Bureau of Economic Research. Treber is Assistant Professor of Economics at Kenyon College. Excellent research assistance was provided by Bradley Epstein, Lauren Hartman and Jill Haubner. We are grateful for comments from Janet Currie, Price Fishback, Gary Libecap, and participants at the All-Ohio Economic Seminar, the 2004 ASSA meetings, Indiana University, the 2004 NBER Summer Institute, Lehigh University and the University of Michigan. Thomasson gratefully acknowledges support from NSF grant # SES-0095990, and support from the National Bureau of Economic Research as a National Fellow during 2002-2003. We accept responsibility for all errors or omissions.

1. Introduction

Childbirth in the United States shifted from home to hospital rapidly in the early twentieth century. In 1900, only five percent of all births occurred in hospitals (Wertz and Wertz 1977, p. 133). By 1935, nearly 75 percent of urban births occurred in hospitals, and nearly all urban births occurred in hospitals by 1950.¹ However, this increase in hospital birth rates did not correspond with a decrease in maternal mortality rates.² Figure 1 shows total, urban (places over 10,000) and rural maternal mortality from 1915-1940. Strikingly, maternal mortality was higher in urban areas than in rural areas until the late 1930s, even though women in urban areas had greater access to hospitals. Figure 2 shows the death rate among women for tuberculosis and all causes related to childbirth (puerperal causes) from 1900-1940. While tuberculosis death rates fell throughout the period, maternal mortality rates, aside from the spike associated with the 1918 influenza epidemic, did not begin to decline until the 1930s.³ Further, infant mortality rates due to birth injuries increased 40-50 percent between 1915 and 1929 as hospital birthrates increased (White House Conference on Child Health and Protection 1933, pp. 215-217).

Why was a shift to hospital birth not reflected in declining maternal mortality rates? Several historians have argued that stagnant maternal mortality rates and rising rates of infant mortality due to birth injury occurred as a result of increased operative intervention on the part of practitioners as birth moved from the home to the hospital. Unnecessary intervention may have led to excess maternal deaths for a number of reasons. A primary cause of maternal mortality was puerperal (related to childbirth) septicemia. Increased operative intervention in the form of version, forceps delivery and cesarean section all increased the mother's likelihood of contracting such an infection. Complications from anesthesia could also lead to maternal death. How preventable was maternal death in this period? Two studies in the

¹ The transition occurred more slowly in rural areas. In 1935, roughly 20 percent of rural births occurred in hospitals. By 1950, over 70 percent of rural births occurred in hospitals, and by the 1960s, it was rare for any birth to occur outside of a hospital (Leavitt 1986, p. 171; Wertz and Wertz 1977 p. 135).

² The maternal mortality rate is defined as the number of maternal deaths per 100,000 live births.

³ The spike in 1918 due to influenza occurs because the U.S. classified influenza deaths among pregnant women as due to puerperal causes instead of influenza. When joint causes of death were present, they were coded using the *Manual of Joint Causes of Death* prepared by the U.S. Bureau of the Census. For each cause of death, the *Manual of Joint Causes* tells what other causes are "preferred" and should be listed as the primary cause if both are present. For example, puerperal septicemia as a primary cause took precedence over tuberculosis, but not over syphilis.

early 1930s claimed that between half and two-thirds of maternal deaths could have been prevented by better training of the attendants (White House Conference on Child Health and Protection 1933; New York Academy of Medicine 1933 p. 213). If these arguments are correct, then modern medicine may have actually increased the number of maternal deaths due to childbirth than otherwise would have occurred.

This paper examines the reasons underlying the shift in childbirth from home to hospital and measures how the hospitalization of childbirth affected maternal mortality. Using a panel of city-level data from 1927-1940, we find evidence that medical intervention slightly increased maternal mortality early in the period and only reduced it following the introduction of sulfa drugs and improved obstetrical practices in the 1930s. The remainder of the paper is structured as follows. Section 2 discusses the background and history of childbirth in the United States, and frames the model discussed in Section 3. Section 4 describes the data and results, while Section 5 concludes.

2. The History of Childbirth in America

Childbirth prior to 1900

Medical intervention during childbirth, even the presence of a physician during labor and delivery, was rare until after 1750, when men trained as physicians abroad returned to practice in America (Wertz and Wertz 1977, p. 29).⁴ In the early nineteenth century, physicians trained in the “new midwifery” in Europe brought forceps to the United States, offering middle- and upper-class women an alternative to traditional, midwife-attended childbirth.⁵ With forceps, physicians could assist women in difficult births, or hasten slow deliveries. Following the advent of ether and chloroform in the mid 1800s, physicians could also reduce the pain associated with childbirth. The idea that physicians could deliver

⁴ Before 1750, a pregnant woman nearing delivery requested the attendance of a midwife and several close friends and relatives who would aid her during the process of childbirth in her home. The technology of childbirth was relatively simple; midwives were generally passive but supportive participants in the birthing process, especially during normal deliveries. They were able to turn breech births, but in complicated cases could do little to prevent either maternal or infant death (Wertz and Wertz 1977, p.17-18). Women feared childbirth, and while actual data are scarce, Leavitt notes that women’s diaries in colonial times (and even through the turn of the twentieth century) showed that “... an important part of women’s experience of childbirth was their anticipation of dying or being permanently injured during the event” (Leavitt 1986, p. 14).

⁵ An Englishman named Peter Chamberlen is believed to have invented forceps in the early 17th century. The device consisted of “... two enlarged spoons with handles” that could be joined and locked together. The Chamberlen family kept the device a secret for over 100 years, so that they were not widely used until after 1800 (Wertz and Wertz 1977, pp. 34-35; Radcliffe 1967, pp. 31-32).

babies more safely and with less pain led women to invite them into the birthing room (Leavitt 1986, pp. 37-38). However, the idea that physician-attended deliveries were in fact safer was not necessarily true. While there are no records of epidemics of puerperal fever in America during the 18th Century; puerperal fever became more common in America after 1840, perhaps because of increasing physician intervention during childbirth (Wertz and Wertz 1977, p. 119).

General practitioners were eager to deliver babies as they viewed childbirth as central to their attempts to build a practice (Wertz and Wertz 1977, p. 67). By the end of the nineteenth century nearly 50 percent of all births were physician-attended, although the majority still occurred in women's homes. Most middle-and upper-class white women were attended by physicians in their homes during childbirth, while Southern black families and immigrants relied heavily on midwives (Litoff 1978, p. 26). The only births that occurred in hospitals were those of homeless women or women who could not receive in-home assistance (Leavitt 1986, p. 61).

The Era of the Hospital: Childbirth after 1900

After the turn of the century, childbirth slowly began to shift from home to hospital. A Children's Bureau study conducted in Baltimore in 1915 may shed some light on trends in urban areas. By 1915, the percentage of births attended by physicians had increased, and women were more likely to deliver in hospitals, although the percentage of women attended by physicians and delivering in hospitals varied widely by both income and nationality of mother, as shown in Tables 1a and 1b (Rochester 1923, pp. 212-213). Physician-attended births in Baltimore hospitals were highest among families where the father reported no earnings and among families of the highest-earning fathers. Middle-class families were more likely to deliver at home while being attended by a physician, while midwives generally limited their services to middle- and lower-income families. Table 1b illustrates the fact that foreign-born mothers in Baltimore were more likely to use midwives than native-born mothers, usually because of a reluctance to admit men into the birthing room. Only 27.4 percent of infants born to white, native-born mothers were delivered by midwives in 1915, while midwives attended the births of over 77 percent of Italian-born women.

What engendered the shift from home- to hospital-based childbirth in the first decades of the twentieth century? The impetus came primarily from physicians who preferred to attend women in hospitals, and the willingness of women to be treated in hospitals because of better anesthesia, a greater perception of safety, and dwindling alternatives.

Physicians preferred to attend women in hospitals for several reasons. First, hospitals became an integral part of physician training following reforms in medical education that occurred in the 1890s and early 1900s.⁶ Thus, increasing numbers of physicians were being routinely trained in hospitals and came to view hospitals as workshops in which they could use the latest medical technologies. Second, hospitals enabled physicians to use technologies that may have been more difficult at home. For example, physicians often had physical difficulty utilizing forceps in the home birthing bed, and some types of anesthesia were best administered in a hospital environment. Third, an increasing awareness of the importance of a germ-free environment to prevent puerperal fever also led doctors to prefer hospital-based over home-based childbirth (Leavitt p. 177). Fourth, in addition to being more comfortable practicing in a hospital setting, physicians also found that centralizing childbirth in hospitals was more convenient and perhaps more lucrative. They no longer had to carry their equipment and travel great distances to women's homes to attend labor and delivery, and hospitals provided trained nurses to assist doctors during delivery (Wertz and Wertz 1977, p. 144; Vogel 1980, pp. 102-103). Doctors could see more patients than they could if they traveled to patient's houses, and hospitals enabled them to do more complicated (and more expensive) procedures.

The idea that physicians may have used excessive intervention to increase their incomes is in line with the modern theory of "supplier-induced demand." For example, Gruber and Owings (1996) found

⁶ In 1893, Johns Hopkins became the first medical school to treat medicine as a field of graduate study, emphasizing science and clinical experience in their training of medical students. The first two years of the four-year program were dedicated to studying science, while the last two were spent in hospital wards. This reform cemented the marriage of physician education to hospital clinical experience, whereas most previous medical school students had learned the practice of medicine "... in their preceptor's office and the patient's home" (Starr 1982, p. 116). Some philanthropists encouraged the development of ties between medical schools and hospitals. Markowitz and Rosner (1973) note several incidences where philanthropists and other industrialists "... attempted to foster consolidation of the medical school and hospital by giving money with certain substantial strings attached," usually requiring hospitals to allow medical schools to use their facilities for teaching (p. 103).

that the decrease in fertility that occurred from 1970-1982 led obstetricians to substitute normal childbirth with more highly compensated cesarean deliveries. Two studies published much earlier are also suggestive of the presence of supplier-induced demand. A 1915 Children's Bureau study found that physicians used forceps (for which they were reimbursed more) in only 4.3 percent of births in families with fathers earning less than \$450, compared to 14.2 percent of births in families with earnings over \$1,850 (Woodbury 1925, p. 236). Similarly, results from the National Health Survey of 1935-1936 found that the cesarean birth rates varied from a low of 1.4 percent among those families on relief to 3.7 percent among those women with a family income of \$2,000 or more. Even more striking, the percentage of hospitalized women undergoing episiotomy ranged from a low of 25 percent among relief families to nearly 50 percent among women with family income over \$2,000. (Goddard 1941, pp. 44-45).

Physicians thus encouraged women to give birth in hospitals because they viewed hospitals as superior places to deliver babies and because it may have benefited them financially. Safety concerns prompted women to adhere to their physician's advice regarding hospitals. Childbirth in the early twentieth-century was hazardous; a 1917 report noted that childbirth in 1913 caused more deaths among women 15 to 44 years old than any disease except tuberculosis (Meigs 1917, p. 7). Advertisements in popular women's magazines trumpeted the virtues of hospital births by proclaiming that "...motherhood is easier and far safer due... to the modern hospital and the great strides made in obstetrics" (*Ladies' Home Journal*, September 1930, p. 83). Advertisements also frequently touted their products as those used by "hospital leaders" and as "hospital-safe" (*Ladies' Home Journal*, February 1932, p. 120).

In addition to supposedly greater safety, there were two other reasons hospital births may have increasingly appealed to women. As hospitals shifted their focus to customer-service, they offered women greater comfort and assistance than women could receive at home. Trained nurses could assist women, and lengthy hospital stays permitted women to rest and escape household duties.⁷ The advent of pain

⁷ Even after a nursing shortage following World War II shortened obstetrical length of stays in hospitals, ward patients stayed an average of two weeks post-partum, and private, paying patients often stayed as long as three weeks, perhaps they "...appreciated the efficiency of transferring to an institution the whole daily round of care, feeding, and washing that could hardly be done anymore in the home" (Wertz and Wertz 1977, p. 156). Leavitt also

relieving drugs and techniques, notably “twilight sleep” in 1914 (Leavitt 1986, p. 130 and Wertz and Wertz 1977, p.150), also likely played a large part in convincing women that hospitals were more comfortable than homes for delivering a child. Although ether and chloroform had been used since the mid 1800s, they were far from ideal. Induction and recovery were slow with ether, and while women were induced much faster using chloroform, it carried higher risks of cardiac complications (Rushman, Davies, Atkinson 1996, pp. 23-26). Most other drugs could not be administered until late in labor, so that women still experienced pain (Leavitt 1986, p. 127).

An advance in the early twentieth-century opened the door for greater anesthetic possibilities. Unlike earlier methods, “twilight sleep” involved the administration of the amnesiac scopolamine, which did not relieve pain but rather prevented women from remembering the painful experience. Pioneered in Germany, U.S. physicians were reluctant to use twilight sleep since they were unsure of its safety. Complications included delayed labor, and infant respiratory depression (Sandelowski 1984, pp. 11-15). Women sometimes had to be restrained during its use, making the hospital the preferred setting for delivery (Sandelowski 1984, p. 16). By slowing labor and incapacitating women, twilight sleep often required obstetrical interventions such as the administration of Pituitrin (a drug used to increase contractions that is related to the modern drug Pitocin) and the applications of forceps to deliver infants. Despite its drawbacks, women campaigned vigorously for its adoption. Proponents of twilight sleep included many wealthy society women, including Mrs. John Jacob Astor, whose picture appeared in newspaper articles endorsing the method (Leavitt 1986, pp. 131-33; Wertz and Wertz 1977, pp. 150-54). While the popularity of the twilight sleep method faded somewhat after 1915 when a noted advocate died during childbirth, the furor it initially created served to increasingly medicalize childbirth, and to make obstetrics an increasingly surgical specialty that routinely involved anesthesia and instrumental intervention.

suggests that urbanization transformed birth from a “woman-centered” event where a woman’s friends and relatives took care of her and her family both during labor and after delivery to one in which women could not find the help they needed (1986, p. 175).

While doctors' advice, safety concerns, and increased comfort and convenience for mothers increased demand for hospital births, a declining supply of midwives also left women with fewer alternatives to physician attended births in hospitals. The reasons underlying the decline in midwives are complex. Diminished demand by women for midwifery services might be partly responsible for the decline in the number of midwives, but there is also evidence that doctors viewed midwives as competitors and sought to limit their ability to practice.

Physicians may have felt threatened economically by midwives who typically received one-half the fee charged by physicians for performing obstetrics services (Litoff 1978, p. 73; Chapin 1923, p. 77). Accordingly, many physicians regarded midwives as inferior substitutes and blamed them for high rates of maternal mortality.⁸ However, it is not clear that poorly trained physicians were better than midwives, especially since the maternal mortality rate did not fall as fewer and fewer women were delivered by midwives over time.⁹ Furthermore, while mothers in Sweden and England relied more extensively on midwives than did mothers in the U.S. (Loudon 1992), both countries realized much lower levels of maternal mortality than the United States, as shown in Figure 4.¹⁰

Declining demand, efforts of physicians to discredit midwives, and many other factors (Litoff 1986, pp. 9-10) contributed to the decline of midwifery during the early twentieth century. The number

⁸ A physician writing in the *American Journal of Obstetrics and Diseases of Women and Children* in 1911 stated, "...40 to 50 per cent. of the births ... are attended by midwives who, except in some rare instances, are ignorant, untrained, incompetent women, and some of the results of their obstetric incompetence are unnecessary deaths and blindness of the infants, and unavoidable invalidism, suffering and deaths of the mothers" (Edgar 1911, p. 881).

⁹ Not even all physicians were convinced of the inferiority of midwives. Speaking in 1911 to the New York Academy of Medicine about the "midwife problem", a New York physician noted that "... much that is said to-night concerning the evil results of midwife practice here in New York, can be said—even to a higher degree—of the physician. The poorly trained physician does far more harm than the midwife, as is abundantly shown by the various hospital records as well as by the records of the Board of Health" (Lobenstine 1911, p. 879).

¹⁰ In America, further evidence of the ability of trained midwives to reduce maternal mortality is given by the example of the Kentucky Frontier Nursing Service, founded by Mary Breckinridge, a nurse who later trained as a midwife in England. In the Frontier Nursing Service, more than 30 nurses trained as midwives in England and then provided midwifery services to families in rural Kentucky. Over the period 1925-1937, the nurse-midwives delivered 3,000 babies. Physicians were called in to perform cesarean sections 6 times, and forceps were used only 14 times. The maternal mortality rate associated with the Frontier Nursing Service over the period was 6.8 deaths per 10,000 births, in contrast to 56-68 deaths per 10,000 births for the U.S. as a whole, and 80-90 deaths per 10,000 births for white women delivered in hospitals in Lexington. (Dye 1983, pp. 501-502). New York City and New Jersey also experienced significant declines in infant mortality after implementing midwife training and regulatory programs (Litoff 1978, p. 93).

of midwives per 100,000 people decreased from 7.39 in 1900 to 2.90 in 1920 and the share of births attended by midwives fell from 50 percent in 1900 to 12.5 percent of births in 1935 (Loudon 1992, p.298).¹¹ This trend was particularly pronounced in large cities. Southern states reported greater numbers of midwives throughout the period and lower levels of decline, as seen in Figure 5.

Impact of Hospital Births on Maternal Mortality

Even as increasing numbers of American women gave birth in hospitals, maternal mortality did not decline. It may be argued that the seeming rise (or lack of decline) in maternal mortality rates simply resulted from more accurate reporting of maternal deaths by physicians as time progressed, the inclusion of higher mortality states in the U.S. death registration area, or a decline in the birth rate that meant more hazardous first births (primiparity) accounted for a greater share of total births over time. There may have been a tendency on the part of physicians to misreport deaths from puerperal fever in order to avoid blame (Loudon 1992, pp. 35-36). While such deaths were usually classified as due to another puerperal cause such as hemorrhage, so that the overall maternal mortality rate would be the same, some doctors may have coded deaths from puerperal infection as due to non-childbirth related causes. As the quality of vital statistics reporting improved over time, these deaths may have been more accurately reported, so that maternal mortality seemed to increase. These effects were undoubtedly present, but probably small. In a 1917 study that investigated maternal mortality in the U.S. and examined the quality of the data, Meigs states, "... it is safe to say that any marked decrease in the actual death rate from childbirth during the last 13 years could not have been masked by "the improvement in reporting deaths from childbirth (Meigs 1917, p. 18).

It also does not appear to be the case that the overall U.S. maternal mortality rate increased over time simply due to the fact that higher mortality states entered the U.S. death registration area later. Even in those states that were in the death registration area in 1900, maternal mortality did not decline over the period. Figure 3 shows the essentially flat trend until the 1930s in Massachusetts, a state that had

¹¹ In New Jersey, 42 percent of births were attended by midwives in 1918, compared to less than 19 percent in 1930. By 1930, 80 percent of midwives were in the rural South (Stevens 1971, pp. 100, 180).

collected maternal mortality data since 1850. Further, international comparisons, shown in Figure 4, reveal that both England and Sweden had flat or rising maternal mortality rates during the same period, even though they possessed fairly accurate vital statistics data (Loudon 1992, p. 240).

Finally, while it is true that first births are more hazardous than second or third births, it is also true that grand multiparity (four or more births) is more hazardous as well (Loudon 1992, p. 242). If birth rates were declining, then primiparity was increasing, but grand multiparity was decreasing. Thus, the increased risk of maternal mortality associated with higher primiparity may have been offset by the decreased risk of maternal mortality associated with lower grand multiparity. Statistics available from 1920-1940 suggest that as the total birth rate per 1,000 women aged 10-54 fell from 72.6 births to 52.3 births, the percentage of first births as a share of total births rose from 29 percent to 37 percent. At the same time, the share of fourth and subsequent births fell from 35 percent to 24 percent (Linder and Grove 1947, Table 48, Table XIV-A). Given that the decrease in grand multiparity more than offsets the increase in primiparity as a share of total births, it seems unlikely that the overall trend in maternal mortality can be attributed to changes in fertility.

Several studies have suggested that excessive physician intervention in childbirth may have been to blame for the increase in maternal mortality.¹² As early as 1880 physicians were aware of the streptococci bacteria that caused sepsis, often called “child-bed” or “puerperal” fever. Nevertheless, puerperal septicemia remained a leading killer of women of childbearing age until the 1930s, when the anti-infective sulfonamide drugs were developed.¹³ American women attended by physicians and giving

¹²A study conducted by the Children’s Bureau in 1927 and 1928 found that maternal deaths due to puerperal causes were 36 percent higher in urban areas than in rural areas (Maternal Mortality in Fifteen States Children’s Bureau 1934, p. 19). Loudon (1991, p.294) and Leavitt (1986, p.183) also provide evidence that maternal deaths due to puerperal fever remained higher in urban areas than in rural areas. Given the higher incidence of hospital births in urban than rural areas this may suggest that hospitals may have actually increased the risks associated with childbirth. Further evidence is suggested by interracial comparisons: Despite the fact that white mothers were hospitalized with much greater frequency than nonwhite infants (twice as many white births occurred in hospitals than did nonwhite births), the racial gap in maternal mortality did not widen and even narrowed during this time period (Loudon 1991, p. 299).

¹³ Dr. Gerhard Domagk described the antibacterial properties of the first sulfa drug (called “Prontosil”) in results published in February, 1935. The antibacterial action came from the drug’s sulphonamide compounds, which were generally effective against streptococcal agents, and to a lesser extent against staphylococcal infection. The first use in the U.S. occurred in late 1936 (one of the first uses was to save FDR’s son from a life-threatening strep infection

birth in hospitals may have been at increased risk for septicemia, given that they were much more likely to have some sort of physical intervention. Results from the 1935-1936 National Health Survey found that forceps were used "... with two or three times the frequency" in hospital deliveries compared to nonhospitalized deliveries (Goddard 1941, p. 47). One prominent physician, Joseph B. DeLee, recommended the routine use of episiotomy and outlet forceps after sedating patients with ether and scopolamine. Describing this as the "prophylactic forceps operation," DeLee stated that the technique was a "...rounded method for relieving pain, supplementing and anticipating the efforts of Nature, reducing the hemorrhage, and preventing and repairing damage" (DeLee 1920, p. 34).¹⁴ This "meddlesome midwifery" may have increased morbidity and mortality among childbearing women. Drugs slowed delivery and necessitated interventions such as forceps that could transmit infection. Physicians who inappropriately applied forceps risked lacerations of the cervix and perineum, as well as infection and hemorrhage, not to mention the potential risk of injury to the infant.

Two studies conducted in the early 1930s support the notion that physician interference may have harmed women. A study conducted by the New York Academy of Medicine from 1930-1932 found the septicemia death rate to be 1.67 deaths per 1,000 live births in the hospital, but only 0.90 deaths per 1,000 live births for infants delivered at home.¹⁵ A second study conducted by a subcommittee of the White House Conference on Child Health and Protection also suggested that excessive interference led to increased morbidity and mortality, with the result that "... all the advances in medical knowledge have been almost lost to the parturient woman through too great a recourse to instrumental delivery" (White

in December, 1936), and reports of the drug's effectiveness were published in early 1937 so that most physicians would have known about sulfa by summer 1937 (Lesch, 2006). Domagk won the 1939 Nobel Prize for Physiology or Medicine for his work. Until sulfa drugs were developed, between 35-55 percent of maternal deaths were due to sepsis. Eclampsia caused 20-30 percent of deaths, 10 percent were due to hemorrhage, with the remainder due to other causes such as accidents and abortion (Loudon 1991, p. 34; authors' calculations from U.S. Vital Statistics Data, 1925-1940).

¹⁴ Other doctors such as J. Whitridge Williams believed that DeLee proposed excessive intervention, a debate that played out in medical journals in the 1920s (Leavitt 1986, p. 120).

¹⁵ Even if cesarean sections are excluded, the hospital maternal mortality rate falls to 1.07—still 18 percentage points higher than the maternal mortality rate associated with home births (New York Academy of Medicine 1933, p. 85).

House Conference 1933, p. 18). The subcommittee further concluded that better training of medical personnel and a reduction in operative deliveries would reduce maternal mortality.

As physicians began to adhere to stricter standards regarding the indications for operative delivery, maternal mortality may have begun to decline. Looking at Figure 1, there is a slight decline in total maternal mortality beginning in the early 1930s that might be attributed to improved obstetrics standards, although by far the largest change in the 1930s occurred following the widespread adoption of sulfa in the U.S. in 1937. The adoption of sulfa may have changed how hospitalization during childbirth affected women. First, excessive intervention on the part of physicians may have been less fatal, since sulfa would have enabled doctors to treat secondary infections. Second, and perhaps more importantly, if doctors' interventions were necessary and lifesaving in and of themselves, then sulfa would have enabled doctors to prevent secondary infections from claiming lives that would have otherwise been saved. In other words, sulfa may have made medical care even more effective.

3. Model

In this paper, we seek to statistically examine the link between hospital births and maternal mortality, both for the pre- and post-sulfa periods. We begin by using city-level data for the period 1927-1940 that allow us to control for different factors—both medical and socioeconomic—that may have impacted maternal mortality rates.¹⁶ To capture medical factors that may have impacted maternal mortality rates, we include a control for medical inputs. Ideally, this variable would be measured as the percentage of all births in a city occurring in hospitals; however, it is not possible to construct this variable for every year in the sample. Instead, we use hospital beds per 100,000 population to control for medical inputs. Presumably, cities with greater numbers of hospital beds may have provided greater levels of physician-attended, hospital births for several reasons. First, the costs (both actual costs and travel costs) of using a hospital may have been lower in cities with more hospital beds per 100,000. In addition,

¹⁶ Ideally, we would like a panel of city level data from 1920-1950 to more fully capture the shift, given that maternal mortality already begins to fall in the early 1930s. However, consistent city-level information on hospitals is not available until 1927, and beginning in 1943, only county information is reported on maternal mortality. Thus, we limit ourselves to the 1927-1940 period.

if physicians are more likely to locate in areas with greater numbers of hospital beds, then this may have increased the probability that a pregnant woman sought a physician's assistance during delivery and thus increased her chance of delivering in a hospital.

A priori, it is not clear whether the sign on the estimated coefficient on hospital beds per 100,000 should be positive or negative. Clearly, physicians and mothers believed that hospital births were safer. Undoubtedly, the lives of some women were saved by the efforts of a physician during difficult births. On the other hand, we are aware that excessive medical intervention may have claimed lives. As noted, it is possible that the impact of medical inputs on maternal mortality changed during the period of time we are considering. In particular, with the introduction of sulfa drugs in 1937, obstetricians were able to more effectively combat puerperal infections. After sulfa drugs were introduced, doctors could intervene with less chance of spreading an infection that would later claim the mother's life. For this reason we interacted a pair of indicator variables with the hospital beds per 100,000 variable in order to distinguish between pre- and post-1937 effects of medical care on maternal mortality.¹⁷

In order to control for socioeconomic characteristics that may have affected maternal health, we include county level measures of education, real income per capita, and race. Construction of the variables is discussed in the data appendix. Education may be important if maternal health practices influenced maternal mortality. For example, educational deficiencies might also have facilitated the continuing influence of superstition, folk remedies, and "lay referral" even when modern medical care and information was available (Beardsley 1987, pp. 32-35). In addition, better educated people appear to be more behaviorally responsive to health-related information than others (Berger and Leigh 1989, Kenkel 1991, Meara 2001). The percent of the population that is illiterate is included as a measure of educational attainment. As a proxy for income, we include real retail sales per capita (Fishback et al 2001). Income may be important for several reasons. First, women with higher incomes may have been better nourished and thus better able to withstand childbirth and its potential complications. This suggests

¹⁷ The variable PRE1937 is equal to one for observations from 1927-1936 while the variable POST1937 is equal to one for observations from 1937-1940.

that the estimated coefficient on the income variable should be negative. Higher income families may have also been able to obtain better access to medical care. To the extent that medical care lowered maternal mortality, this suggests that the estimated coefficient on the income variable should be negative. However, if medical care did increase the risk of maternal mortality, and to the extent that the hospital beds per 100,000 variable inadequately captures the impact of medical care on maternal mortality, then the estimated coefficient on the income variable may be positive.

The percentage of the population that is black (also from the census) is included to measure the extent to which racial differences impacted maternal mortality. The percentage of the population that is foreign born is included to account for any greater propensity among the immigrant population to avoid physician assisted births and rely more on midwives, family, and friends. Finally, women under 16 years of age and women over 35 are at a greater risk for puerperal complications (Cunningham et al 1997, pp. 570-572). As a control for this potential maternal health risk we include variables reflecting females in various age groups as a percentage of women in their childbearing years (ages 15 to 44). Thus, our basic regression equation is:

$$MMR_{it} = Z_{it}\alpha + [V_t*Z_{it}]\theta + [Y_t*Z_{it}]\pi + X_{it}\beta + e_{it} ,$$

where i refers to cities, t refers to years, Z_{it} reflects hospital beds per 100,000, V_t is the dummy variable indicating whether the observation occurred in the period from 1927 to 1936, Y_t is the dummy variable indicating whether the observation occurred in the period 1937 to 1940, and X_{it} includes the city-year characteristics described above. We include state and year dummies to capture any additional effects that vary across states but were constant over time or that varied across time but were constant across cities. Finally, because it could be the case that cities that were added to the registration areas after 1927 may have had greater levels of maternal mortality and more incomplete registration of maternal deaths as well as infant births, we run a balanced panel consisting of only those cities that were in the sample in the first year (1927) and an unbalanced panel consisting of all cities regardless of when they entered the sample. Table 2 presents summary statistics for the variables.

4. Results

Regression results are reported in Table 3. Results from the balanced panel, reported in column [1], show that hospitalization slightly increased maternal mortality prior to the introduction of sulfa and slightly decreased it after. An increase of 100 beds per 100,000 population increased maternal mortality by 7.9 deaths per 100,000 births through 1936 and decreased it by 9.5 deaths per 100,000 births after 1936. These results are consistent with the conjecture that until the late 1930s obstetrical devotion to medical intervention rendered medical care detrimental to the health of women during the birthing process. The introduction of anti-infective sulfa drugs and improving obstetrics practices enabled obstetricians to prevent injury and combat infections induced by their medical interventions later in the 1930s.¹⁸

Results for the unbalanced panel, reported in column [2] are somewhat different. The reason we use the balanced panel is because it may have been the case that cities added to the birth registration area later might have had higher rates of maternal mortality. This is consistent with the summary statistics presented in Table 2; the mean maternal mortality rate for the full sample is 627 deaths per 100,000 births, compared to 598 deaths per 100,000 births in the balanced panel. To a large extent, the cities added later were in the South, where hospital quality may have been more dubious than in northern cities, and where blacks in particular had a more difficult time obtaining access to hospitals. The results reported in column [2] are consistent with these hypotheses. The estimated coefficient on the interaction term pre-1937 is positive and larger in magnitude than the estimated coefficient in the balanced panel, suggesting that prior to 1937 medical care provided in hospitals may have increased maternal mortality. Unlike results from the balanced panel, the estimated coefficient on the interaction term post-1937 is positive (although not statistically significant), suggesting that hospitals did not lower maternal mortality after 1936.

¹⁸ Sulfa drugs were effective against puerperal fever, but not as effective as antibiotics. City-level data are not reported beyond 1943, and antibiotics were not widely produced until 1946. However, state level data run for the period 1937-1950 (not reported here) show that penicillin had an even stronger impact on reducing maternal mortality after 1946.

In both columns [1] and [2], other statistically significant variables include percent illiterate, percent foreign-born, and percent black, all of which have the expected sign. The estimated coefficient on percent foreign born is negative and statistically significant, indicating that cities with greater foreign-born populations had less maternal mortality, perhaps because foreign-born mothers were more likely to rely on midwives and less likely to go to the hospital. Less educated women had higher maternal mortality, as did blacks.

To more fully examine whether the increasing hospitalization of the birthing process had a differential impact on black mothers compared to white mothers we also estimate separate regressions by race.¹⁹ Blacks, particularly in the South, may have had difficulty gaining access to quality medical care. Black women may have preferred to use black physicians, who were often excluded from good medical schools and residencies, and denied privileges at all but black hospitals or hospitals for the indigent, many of which were unable to keep up with rapidly advancing medical technologies (Smith 1999, p. 21). Even if blacks did not prefer to be attended by black physicians, they may have been excluded from other hospitals or restricted to segregated facilities that offered lower quality care, especially in Southern cities (Almond, Chay and Greenstone 2001). If blacks were restricted in their access to certain hospitals, or if they received substandard care, we would expect to see a differential effect of hospitals on black maternal mortality relative to white maternal mortality.

Summary statistics by race are provided in Tables 4 and 5. Estimates from the race regressions are provided in Tables 6 and 7. In the period before sulfa, hospitals had an adverse impact on maternal mortality for both blacks and whites, although much more so for blacks. Post-sulfa, hospital care lowers maternal mortality for whites (although the result is only statistically significant in the balanced panel), but does not statistically significantly affect black maternal mortality, a result that is consistent with the hypothesis that blacks received lower quality medical care.

¹⁹ The number of observations in the race regressions is significantly lower than for the regressions based on the total population as mortality and birth data were only provided for cities in which the minority population was greater than 10,000 or 10% of the total population. Also, mortality data by cause of death was not reported by race at the city level in 1938.

5. Discussion

Despite the fact that hospital births increased dramatically over the period 1920 to 1950, maternal mortality rates did not decline until the 1930s when sulfa drugs were developed. This paper seeks to understand the relationship between hospital care and maternal mortality. Did maternal mortality rates remain flat and even increase because of iatrogenic causes? Results based on a sample of city-level data from 1927-1940 provide support for the hypothesis that medical intervention associated with hospital births did increase maternal mortality rates for much of this period. From 1927-1936 the number of hospital beds per 100,000 people in a city seems to have increased maternal mortality, albeit very slightly. However, the development of sulfa and more judicious use of medical interventions by physicians during childbirth led to hospitals actually reducing maternal mortality rates, at least for whites. In a sense, sulfa drugs made medical care more effective by not only directly reducing deaths from naturally occurring cases of puerperal fever, but also by enabling doctors to perform potentially life-saving procedures such as cesarean sections without the risk of subsequent life-threatening infections.

Regressions estimated separately by race reinforce the overall results that medical care increased maternal mortality prior to 1937, but also suggest that the impact of medical care on maternal mortality differed for blacks and whites. Relative to whites, hospitals posed a greater risk for black mothers prior to the availability of sulfa drugs in 1937, and were less beneficial for them afterwards, suggesting that blacks received lower quality medical care.

If medical care did not contribute to reducing maternal mortality, why did women increasingly turn to hospitals for childbirth? There are potential explanations that would reconcile this apparent contradiction. First, it may be very likely that women were not aware of the increased risk. According to our results, hospitals increased maternal mortality in the late 1920s and early 1930s by only 8-11 deaths per 100,000 births, a number that few women may have noticed. Additionally, physicians, be it out of altruistic concern or to further their own financial position, promoted hospitals as a safer birthing environment. It is not clear whether physicians did so because they truly believed this assertion or

because they were motivated by the convenience and higher incomes that a hospital based practice could offer. Regardless of their motivations, there does not appear to have been much evidence available at that time to give women any reason to doubt their physician's claims. Even if we assume that women were perfectly informed about the risks of hospital births, there is still reason to believe that they may have preferred the hospital setting. Hospitals offered women more comfort (with anesthesia) and greater rest than women could have achieved with home births. There were fewer family members to care for women at home and fewer midwives available as an alternative to a physician. Therefore, it is quite possible that the benefits of hospital births were, to many women, worth the increased risk.

In general, it may seem reasonable to assume that movements towards increasing medical intervention are driven primarily by safety concerns. However, deeper examination reveals that this may not always be the case. This paper has illustrated that the transitioning of childbirth from the home to hospital appears to have initially increased the mortality risk to mothers. It is worth noting that just because this movement did not improve the safety of mothers does not imply that mothers did not benefit overall. Rather, it suggests that intuitive safety explanations may not be correct and that greater analysis should be performed when assessing changes in medical technology or methods. Similar analysis of contemporary changes in medicine may prove useful in assessing to what extent society has benefited from technological changes and to identify when problems of imperfect information may be leading to non-optimal outcomes.

DATA APPENDIX

Data on maternal deaths and number of live births were obtained from reports on vital statistics published annually by the U.S. Bureau of the Census. These reports provided data at the city level for each city with a population of at least 10,000. There were 941 cities consistently represented in these reports. The maternal mortality variable was constructed by dividing maternal deaths by live births and multiplying by 100,000. This variable was used as the dependent variable in all regressions.

The American Medical Association's annual report on "Hospital Service in the United States" provided a listing of hospital beds by city. From this report an annual count of hospital beds could be obtained for each city. City populations for 1920, 1930, and 1940 were obtained from the Fourteenth, Fifteenth, and Sixteenth U.S. population censuses. Populations for all other years were calculated using a straight line interpolation between the two closest census years. The hospital beds and city population data were utilized to construct a hospital beds per 100,000 population variable. This variable was included in the regressions as an explanatory variable representing medical inputs.

Socioeconomic variables were constructed based on county level census data. Percent black, percent foreign born, percent illiterate and percentages of females in different age groups were calculated for 1920, 1930, and 1940. Straight line interpolation was used to obtain values for all other years. The percent black and percent foreign born variables were created based on population data obtained from Historical, Demographic, Economic, and Social Data: The United States, 1790-1970, ICPSR file 0003, as corrected by Michael Haines. The percent female variables represent the number of females in each age group as a percent of the female population from 15 to 44 years of age. These variables were calculated from data provided in Gardner and Cohen's ICPSR file 0020 and the Fourteenth U.S. population census. For 1920 and 1930, the percent illiterate variable was calculated as the percentage of the population aged 10 and older that was illiterate. This data was captured in the 1920 and 1930 censuses and reported in ICPSR file 0003 as corrected by Michael Haines. However, beginning in 1940 the illiteracy counts were replaced in the census by years of schooling completed for people over 24 years old. We were able to combine this data with illiteracy data by age group and level of education for the entire U.S., obtained from the U.S. Bureau of the Census (1948, 7), to calculate percent illiterate for 1940. This process involved computing separate national illiteracy rates for males and females over 24 years old with no schooling (78.2% and 80.7% respectively) and males and females over 24 years old with one to four years of schooling (22.5% and 16.7% respectively). Applying these percentages to the census figures for the population aged 25 and older by sex and years of schooling provided a count of illiteracy from which we could calculate the percent illiterate. This is the same method utilized by Thomasson (2002) and Fishback et al. (2001).

The last socioeconomic variable included in the regressions was real retail sales per capita. This variable was constructed from county level data on population and retail sales. Population data for 1920, 1930, 1940, and 1950 was obtained from ICPSR file 0003 as corrected by Michael Haines. We used straight line interpolation to obtain population counts for 1929, 1933, 1935, 1939, and 1948. These were the only years in which retail sales information was available. Retail sales data for 1929 and 1939 were obtained from ICPSR file 0003 as corrected by Michael Haines. For 1933 and 1935 the data were acquired from the U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, 1936 and 1939. Lastly, 1948 retail sales figures were pulled from the City and County Data Book Consolidated File, County Data 1947-1977, ICPSR file 7736. The retail sales per capita variable was calculated directly for these years and was interpolated for all other years. The interpolation procedure involved a weighting mechanism based on changes in per capita state income. This was included to reflect the likelihood that retail sales per capita was closely linked to general economic performance. This variable was also adjusted for inflation.

REFERENCES

- Almond, D.V., Chay, K.Y., Greenstone, M., 2001. Civil rights, the war on poverty, and black-white convergence in infant mortality rates in Mississippi. Working paper.
- American Medical Association, Council on Medical Education, 1928-1941. Hospital service in the United States, various issues. Chicago: American Medical Association.
- Beardsley, E.H., 1987. A history of neglect: health care for blacks and mill workers in the twentieth-century South. University of Tennessee Press, Knoxville.
- Berger, M.C., Leigh, J.P., 1989. Schooling, self-selection, and health. *Journal of Human Resources* 24 (3), 433-455.
- Chapin, C.V., 1923. The control of midwifery. *Medical Progress*, 39, 76-79.
- Cunningham, F.G., MacDonald, P.C., Gant, N.F., Leveno, K.J., Gilstrap III, L.C., Hankins, G.D.V., Clark, S.L., 1997. *Williams obstetrics*, 20th ed. Appleton & Lange, Stamford, CT.
- De Lee, J.B., 1920. The prophylactic forceps operation. *American Journal of Obstetrics and Gynecology*, 1, 34-44.
- Dye, N.S., Breckinridge, M., 1983. The frontier nursing service and the introduction of nurse-midwifery in the United States. *Bulletin of the History of Medicine* 57 (4), 485-507.
- Edgar, J.C., 1911. The remedy for the midwife problem. *American Journal of Obstetrics and Diseases of Women and Children* 63, 881-884.
- Fishback, P.V., Horrace, W.C., Kantor, S.E., 2001. The Impact of New Deal Expenditures on Local Economic Activity: An Examination of Retail Sales, 1929-1939. National Bureau of Economic Research Working Paper #W8108.
- Gardner, J., Cohen, W., 1992. Demographic characteristics of the population of the United States, 1930-1950: county-level, ICPSR file 0020.
- Goddard, J.C., 1941. Medical and nursing services for the maternal cases of the national health survey. U.S. Public Health Bulletin No. 264. Government Printing Office, Washington.
- Gruber, J., Owings, M., 1996. Physician financial incentives and cesarean section delivery. *RAND Journal of Economics* 27 (1), 99-123.
- Inter-University Consortium for Political and Social Research. Historical, demographic, economic, and social data: The United States, 1790-1970, ICPSR file 0003. Computerized data tapes from ICPSR. The version has corrections by Michael Haines, Department of Economics, Colgate University, Hamilton, NY.
- Kenkel, D.S., 1991. Health behavior, health knowledge, and schooling. *Journal of Political Economy* 99 (2), 287-305.
- Ladies Home Journal, various issues, 1930-1932.

- Leavitt, J.W., 1986. Brought to bed. Oxford University Press, New York.
- Lesch, J.E., 2006. The first miracle drugs: how the sulfa drugs transformed medicine. Oxford University Press, New York.
- Linder, F.E., Grove, R.D., 1943. Vital statistics rates in the United States, 1900-1940. Government Printing Office, Washington, D.C.
- Litoff, J.B., 1978. American midwives, 1860 to the present. Greenwood Press, Westport, Connecticut.
- Litoff, J.B., 1986. The American Midwife Debate. Greenwood Press, New York.
- Lobenstein, R.W., 1911. The influence of the midwife upon infant and maternal morbidity and mortality. American Journal of Obstetrics and Diseases of Women and Children 63, 876-880.
- Loudon, I., 1991. On maternal and infant mortality 1900-1960. Social History of Medicine 4, 29-73.
- Loudon, I., 1992. Death in childbirth: an international study of maternal care and maternal mortality 1800-1950. Clarendon Press, Oxford.
- Markowitz, G.E., Rosner, D.K., 1973. Doctors in crisis: a study of the use of medical education reform to establish modern professional elitism in medicine. American Quarterly 25, 83-107.
- Meara, E., 2001. Why is health related to socioeconomic status? the case of pregnancy and low birth weight. NBER Working Paper 8231.
- Meigs, G.L., 1917. Maternal mortality from all conditions connected with childbirth in the United States and certain other countries. U.S. Department of Labor Children's Bureau, Miscellaneous Series No. 6, Bureau Publication No. 19. Government Printing Office, Washington, D.C.
- New York Academy of Medicine Committee on Public Health Relations, 1933. Maternal mortality in New York City: a study of all puerperal deaths, 1930-1932. Commonwealth Fund, New York.
- Radcliffe, W., 1967. Milestones in midwifery. John Wright & Sons Ltd., Bristol.
- Rochester, A., 1923. Infant mortality: results of a field study in Baltimore, MD based on births in one year. U.S. Children's Bureau Publication No. 119. Government Printing Office, Washington, D.C.
- Rushman, G.B., Davies, N.J.H., Atkinson, R.S., 1996. A short history of anesthesia: the first 150 years. Butterworth-Heinemann, Oxford.
- Sandelowski, M., 1984. Pain, pleasure and American childbirth: from the twilight sleep to the read method, 1914-1960. Greenwood Press, Westport, Connecticut.
- Smith, D.B., 1999. Health care divided: race and healing a nation. The University of Michigan Press, Ann Arbor.
- Starr, P., 1982. The social transformation of American medicine. Basic Books, New York.

- Stevens, R., 1971. American medicine and the public interest. Yale University Press, New Haven and London.
- Thomasson, M.A., 2002. From sickness to health: the twentieth century development of US health insurance. *Explorations in Economic History* 39 (3), 233-53.
- U.S. Bureau of the Census, 1930-1934. Birth, stillbirth, and infant mortality statistics for the birth registration area of the United States, various issues. Government Printing Office, Washington, D.C.
- U.S. Bureau of the Census, 1933-1938. Birth, stillbirth, and infant mortality statistics for the continental United States, the territory of Hawaii, and the Virgin Islands, various issues. Government Printing Office, Washington, D.C.
- U.S. Bureau of the Census, 1999 [1978]. County and city data book consolidated file, county data 1947-1977. ICPSR , machine-readable data file 7736 [original publication 1978, The Census Bureau, Washington, D.C.]
- U.S. Bureau of the Census, 1948, Illiteracy in the United States, October 1947, current population reports: population characteristics, series P-20 no. 20.
- U.S. Bureau of the Census, 1929-1938. Mortality statistics annual reports. Government Printing Office, Washington, D.C.
- U.S. Bureau of the Census, 1904. Special reports: occupations of the twelfth census. Government Printing Office, Washington, D.C.
- U.S. Bureau of the Census, 1939-1943. Vital statistics of the United States, various issues. Government Printing Office, Washington, D.C.
- U.S. Bureau of the Census, 1921. Fourteenth census of the United States: population, volumes I & II. Government Printing Office, Washington, D.C.
- U.S. Bureau of the Census, 1933. Fifteenth census of the United States: population, volume VI, families. Government Printing Office, Washington, D.C.
- U.S. Bureau of the Census, 1942. Sixteenth census of the United States: population, volume I, number of inhabitants. Government Printing Office, Washington, D.C.
- U.S. Bureau of the Census, 1952. Seventeenth census of the United States: population, volume II, parts 2-50, characteristics of population. Government Printing Office, Washington, D.C.
- U.S. Bureau of Economic Analysis, 1989. State personal income: 1929-1987. Government Printing Office, Washington, D.C.

Wertz, R.W., Wertz, D.C., 1989. *Lying-in: a history of childbirth in America*. Yale University Press, New Haven and London.

Woodbury, R.M., 1925. *Causal factors in infant mortality: a statistical study based on investigations in eight cities*. U.S. Children's Bureau Publication No. 142. Government Printing Office, Washington, D.C.

Vogel, M.J., 1980 *The invention of the modern hospital, Boston, 1870-1930*. The University of Chicago Press, Chicago.

White House Conference on Child Health and Protection, 1933. *Fetal, newborn and maternal morbidity and mortality*. D. Appleton-Century Company, New York and London.

