ARTICLE

Impact of Postpartum Hospital-Stay Legislation on Newborn Length of Stay, Readmission, and Mortality in California

Ashlesha Datar, PhD, Neeraj Sood, PhD

RAND Corporation, Santa Monica, California

The authors have indicated they have no financial relationships relevant to this article to disclose.

ABSTRACT

OBJECTIVES. The objectives of this study were to examine the impact of postpartum hospital-stay legislation on newborns' length of stay, neonatal readmissions, and 1-year mortality in California, and whether this legislation had differential impacts by demographics and complications during delivery or pregnancy.

METHODOLOGY. This study used linked birth certificates, death certificates and hospital discharge records for all full-term, normal birth weight, and singleton-birth newborns during 1991–2000 in California (n = 662 753). Interrupted time-series analyses were used to examine changes in newborns' length of stay and outcomes after 1 year, 2 years, and 3 years since the passage of postpartum laws. Multivariate linear and logistic regressions were estimated separately by maternal characteristics (race, education, age, and partity), delivery type, and complications during pregnancy or delivery.

RESULTS. Length of stay increased by 9.5, 12, and 14 hours in years 1, 2, and 3, respectively, after the passage of the law. Increases were larger for newborns of white mothers, more educated mothers, mothers >35 years of age, primaparous mothers, cesarean deliveries, and Medicaid recipients, but there were no differences by pregnancy or delivery complications. The odds of neonatal readmission declined by 9.3%, 11.8%, and 19.7% in years 1, 2 and 3 after the law, respectively. The odds of infection-related readmissions declined by 21.5% and 30.3% in years 2 and 3, respectively. The odds of jaundice-related readmissions increased by 7% in year 1. There was no significant change in either the odds of readmission due to respiratory problems or the odds of 1-year mortality in the postlaw years. Demographic differences in the impact of the law on readmissions and mortality could not be detected because of lack of statistical power.

CONCLUSIONS. Postpartum length of stay legislation was associated with increased length of stay among all births in California, with significant variation in the law's impact across demographic groups. After the law's passage, there was a significant decline in neonatal readmissions but not in 1-year mortality.

www.pediatrics.org/cgi/doi/10.1542/peds.2005-3044

doi:10.1542/peds.2005-3044

The views in this article are those of the authors and not of the granting agency or RAND.

Key Words
length of stay, legislation, newborn, readmission rates, mortality rates

Abbreviations
LOS—length of stay
HMO—health maintenance organization
OSHPD—Office of Statewide Health Planning and Development
SIDS—sudden infant death syndrome
CHM—congenital heart malformation

Accepted for publication Feb 13, 2006

Address correspondence to Ashlesha Datar, PhD, RAND Corporation, 1776 Main St, Santa Monica, CA 90407. E-mail: datar@rand.org

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275). Copyright © 2006 by the American Academy of Pediatrics

Downloaded from www.aappublications.org/news by guest on December 2, 2020

POSTPARTUM HOSPITAL LENGTH of stay (LOS) of newborns in the United States declined steadily from 1970 until the mid-1990s.[1,2] The average LOS for vaginal deliveries in 1970 was 3.9 days compared with 2.0 days in 1993. For cesarean sections, the mean postpartum stay declined from 7.9 to 3.9 days over the same period. Rapid discharge of vaginally delivered newborns has also been more commonly documented since the mid-1990s.[3–5]

In response to concerns about the potential adverse effects of such trends on maternal and infant health outcomes, both state and federal governments passed a series of highly publicized postpartum discharge laws in the mid-to-late 1990s that sought to reduce the incidence of extremely short newborn hospital stays. Although there were some variations across states in certain elements of the law (eg, decision-maker, required postdischarge care, and the covered population), these laws generally required insurance plans to cover postpartum hospital stays of ≥48 hours for vaginal deliveries and ≥96 hours for cesarean sections.[6]

Proponents of the law argued that longer postpartum stays may help reduce the risk for diseases such as jaundice, facilitate early diagnosis of diseases such as congenital heart disease, train mothers in proper infant care techniques, and enhance the use of newborn screening tests. However, at the time these laws were passed, there was limited empirical support for the claim that reducing the incidence of short lengths of stay would prevent adverse infant outcomes. In a 1995 review article, the research literature on the health effects of postpartum LOS was found to be inconclusive, largely because of unreliable study designs.[7] A subsequent study published in 2000 examined the causal effect of postpartum LOS on newborn readmissions in the state of Washington using birth hour as an instrumental variable for LOS and found that a 12-hour longer stay reduced the 28-day readmission rate by 18%.[8]

The passage of the postpartum hospital-stay laws presented a "natural experiment" and provided the opportunity to reexamine this issue using rigorous study designs. Three previous studies have used interrupted time series analysis to examine the effects of postpartum LOS legislation on postdischarge clinical outcomes and health care use in 2 states.[9–11] However, these studies only used data on specific subpopulations, such as Medicaid recipients and enrollees in 1 large health maintenance organization (HMO). One national study used differences across states in adoption dates and law specifics to examine the impact of the legislation, but the outcomes were limited to hospital spending only.[6]

This study uses linked birth certificates, death certificates, and hospital discharge records for the years 1991–2000 from the state of California to examine the effect of the state and federal postpartum LOS legislation on postpartum LOS, newborn hospital readmissions, and 1-year mortality. The data span the year that California passed its postpartum LOS legislation (August 1997) and the year in which the federal postpartum legislation was enacted (January 1998). This study builds on the previous literature in a number of important ways. First, the impact of postpartum legislation has not been examined previously in California. Second, unlike previous studies that used data on particular subpopulations, this study uses data on all of the births in the state during the period 1991–2000. The large sample size of the current study allows us to evaluate the impact of the legislation on overall and cause-specific neonatal readmissions and 1-year mortality. Third, the current study not only evaluates the average effect of the law for all California-born infants but also examines whether the law differentially affected postpartum LOS for mothers and infants with different demographics and pregnancy or delivery-related complications. This analysis of differential effects of the law is important for both clinicians and policy-makers, because it evaluates whether the law was well targeted (ie, if it had a larger impact on subpopulations that have a greater risk of adverse outcomes because of early discharge) and highlights subpopulations that might be at risk of early discharge and adverse outcomes.

METHODS

Study Design

California's postpartum LOS legislation was introduced on December 2, 1996, and was adopted on August 26, 1997. The federal postpartum legislation was adopted on January 1, 1998. Both the California and federal legislations prohibited insurance plans from limiting coverage for postpartum hospital stay to <48 hours for normal vaginal deliveries and <96 hours for cesarean sections. In addition, the state legislation also mandated follow-up visits in the event of an early discharge, which was not required by the federal legislation.

We used interrupted time series analyses to examine changes in newborns' LOS and outcomes after 1 (1998), 2 (1999), and 3 (2000) years since the passage of these laws. We measured the impact of these laws by estimating the deviation in outcomes from the prelaw trend for each of the 3 years past the enactment of the laws.

Our analyses are based on a linked database of birth certificate, death certificate, and hospital discharge data from California for the years 1991–2000, which is maintained by California's Office of Statewide Health Planning and Development (OSHPD). The linkage methods are described in a previous study.[12] Multiple-birth newborns were excluded from this database, because their records could not be linked accurately. The database contains linked records for ~98% of singleton liveborn births that occurred in civilian California hospitals.[12] The database includes the year and hour of birth, number of nights in the hospital after birth, sociodemographics and

Downloaded from www.aappublications.org/news by guest on December 2, 2020

clinical characteristics of the newborn and the mother, cause-specific hospital readmission during the first year, as well as the date and cause of death within the first year. Information on the exact month of birth was excluded from the database for confidentiality reasons.

Our analysis sample excludes newborns who died before discharge, were transferred to another facility, had implausibly short or missing LOS or missing birth hour, medically unattended births, and fetal deaths, which in total constituted 3% of the original data. In addition, we also excluded premature and low birth weight infants from our sample, because the law is unlikely to directly affect these infants. This resulted in a sample size of 4 662 753 births. The descriptive statistics of our sample are shown in Table 1. The data show some differences in population demographics in the prelaw and postlaw years, highlighting the importance of controlling for these factors. For example, mothers in the postlaw years were more likely to have a high school degree, be ≥35 years of age, have non-Medicaid insurance, and have a higher likelihood of complications during delivery or pregnancy.

TABLE 1 Descriptive Statistics

Variable	Prelaw (1991–1997)	Postlaw (1998–2000)
Outcomes		
LOS, h	42.6	49.3
Neonatal readmissions, per 1000 births		
All causes	30.3	29.2
Jaundice	10.0	10.8
Infection	2.8	2.9
Respiratory problems	1.5	1.5
Died within 1 y, per 1000 births		
All causes	1.6	1.0
SIDS	0.6	0.3
CHMs	0.1	0.1
Covariates, %		
Race		
White	40.6	37.6
Black	6.2	5.6
Hispanic	41.6	43.7
Other	10.7	11.8
Mother's education		
<high school	33.9	29.8
≥High school	66.1	70.2
Mother's age, y		
<18	4.6	3.9
18–35	82.9	80.8
>35	12.6	15.3
Insurance type		
Medicaid (MediCal)	44.5	40.1
Non-Medicaid insured	49.7	55.9
Uninsured	5.7	4.0
Multiparous	61.0	61.5
Newborn risk factors		
Infection	1.4	1.2
Respiratory problems	4.6	4.6
Trauma	5.7	4.5
Seizures	0.05	0.05
Cesarean delivery	20.1	21.1
Any delivery complications	69.5	74.6
Any pregnancy complications	56.0	64.8
No.	3 340 160	1 322 593

Source: Linked database of birth certificate, death certificate, and hospital discharge data from California for the years 1991–2000, which is maintained by California's OSHPD. Data for this table exclude preterm, low birth weight, and multiple-birth newborns.

The primary outcomes in our analyses include hospital readmission of a newborn in the neonatal period (within 28 days after birth), cause-specific neonatal readmission, mortality within 1 year after birth, and cause-specific mortality within 1 year. We are unable to examine neonatal mortality because of very low prevalence of this outcome. The specific causes of 1-year mortality that we examine include sudden infant death syndrome (SIDS) and congenital heart malformations (CHMs). We examine neonatal readmissions because of jaundice, infection, and respiratory problems. The *International Classification of Diseases, Ninth Revision, Clinical Modification* code on death certificates and hospital discharge records is used to determine newborns' causes of death and readmission, respectively. We examine SIDS and CHMs, because they are common causes of death among newborns and might be prevented with extended postpartum stays.[13–16] For example, SIDS may be averted if mothers are trained in the early days after birth to have infants sleep on their backs. Heart problems and infections may also be cured if they are detected and treated expeditiously. Similarly, we examine jaundice, infection, and respiratory problems, because they are common causes of readmissions, and previous research suggests that they might be prevented with longer postpartum stays.[8,9,11] Very low prevalence of other causes of mortality or readmission in our sample prevented us from examining them separately.

Because the hospital discharge records did not collect data on the time of discharge, it is not straightforward to construct the LOS variable in hours. We follow the approach in Malkin et al[8] and impute LOS in hours using the hour of birth, the number of nights hospitalized, and assumptions about the time of discharge. We assume that newborns discharged the same day they were born were discharged at 5 PM. Those discharged after 1 or more nights of stay at the hospital are assumed to be discharged at 1 PM. These discharge times are based on a previous study of newborns in Los Angeles and Iowa.[17] The validity of this imputation approach is documented in a previous study.[8]

Statistical Analysis

We measure the impact of the postpartum law by estimating the deviation in LOS and outcomes in each of the 3 years past the enactment of the law from their prelaw trends. The impact on newborn LOS is estimated using a multivariate linear regression model where LOS (measured in hours) is the dependent variable. The model includes a constant, a time trend variable to control for

Downloaded from www.aappublications.org/news by guest on December 2, 2020

any secular time trends, and 3 terms estimating changes in the LOS 1, 2, and 3 years after the passage of the law. We also include a number of other control variables, including maternal characteristics, such as race, education, age at birth, insurance status, and parity; newborn's gender; and infant risk factors at the time of birth, such as trauma, seizures, infection, respiratory problems, indicators for any pregnancy or labor complications, and an indicator for cesarean delivery. The delivery complications used to construct the complication indicator variables included preeclampsia, eclampsia, pyelonephritis, hypertension, renal disease, anemia, lung disease, cardiac disease, hemoglobinopathy, polyhydramnios, genital herpes, other sexually transmitted diseases, hepatitis, rubella, incompetent cervix, tobacco use during pregnancy, uterine bleeding before labor, previous history of premature births, low birth weight, and other complications. The labor complications used to construct the complication indicator variable include seizure during labor, fetopelvic disproportion, shoulder dystocia, breech or other abnormal presentation, precipitous labor (<3 hours), prolonged labor (>20 hours), premature rupture of membrane, induction of labor, abruptio placenta, placenta previa, sepsis, febrile, cord prolapse, fetal distress, anesthetic complications, and maternal blood transfusion.

The LOS regression was estimated for births during 1991–2000. We included the year 1997 as a prelaw year, because the largest change in LOS only occurred in 1998 (as seen in Fig 1), the first full year that the state (and federal) law was in effect. We first estimated the LOS regression model for our full analysis sample. We also estimated the LOS models separately by insurance type (Medicaid, non-Medicaid, and uninsured), because the law did not cover Medicaid and uninsured births. Next, we estimated the LOS models separately by selected characteristics, including mother's education (less than high school, high school, or more), maternal age at birth (18–35 or >35), race (white or Hispanic), parity (multiparous or primiparous), delivery type (cesarean or vaginal), and indicators for whether there were certain complications during delivery or pregnancy.

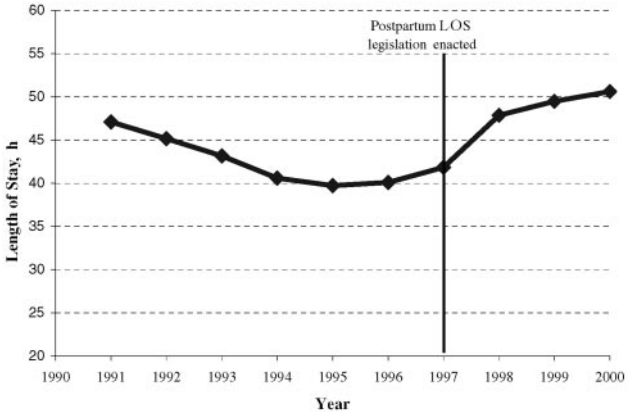

FIGURE 1
Mean hospital LOS of newborns in California, 1991–2000. Source: linked database of birth certificate, death certificate, and hospital discharge data from California for the years 1991–2000, which is maintained by California's OSHPD. Data for this figure exclude preterm, low birth weight, and multiple-birth newborns.

The impact of the law on infant outcomes, such as neonatal readmission and 1-year mortality, is estimated using multivariate logistic model, because the outcome variables are dichotomous. The logistic model includes a constant term; a time trend variable to control for any secular time trends; 3 terms estimating changes in the LOS 1, 2, and 3 years after the law's passage; and the same set of control variables included in the linear model described above. The interpretation of the coefficients from the logistic model is different from that of coefficients in the linear model. In the logistic model, the coefficient on the time trend variable can be interpreted as the annual growth rate in the odds of observing the outcome. Coefficients on the 3 terms that estimate changes in infant outcomes in the postlaw years can be interpreted as percentage changes in the odds of observing the outcome 1, 2, and 3 years after the passage of the law (or, simply, changes in log odds of the outcome).

In both linear and logistic models, we adjust the SEs of regression estimates to account for correlations in LOS and outcomes of infants born in the same hospitals. This is done by estimating Huber-White SEs using the "cluster" option in STATA 8 (Stata Corp, College Station, TX). Two-tailed significance tests were performed to detect statistically significant estimates and to test for differences between estimates.

RESULTS

LOS

Figure 1 shows the mean LOS in hours by year during the period 1991–2000. There was a rapid decline in mean LOS of newborns between 1991 and 1994, dropping from 47 hours in 1991 to just >40 hours in 1994. During 1994–1996, the mean LOS remained relatively stable. In the year that the law in California was passed, the mean LOS increased to ~42 hours. This marginal increase in mean LOS in 1997 may be attributed to the fact that the state law was in effect for only 4 months in 1997. The main shift in mean LOS occurred in 1998, the first full year that the law in California was in effect. Moreover, the federal postpartum LOS legislation also went into effect on January 1, 1998. Mean LOS jumped sharply to ~48 hours in that year, after which it increased to 49 hours in 1999 and 51 hours in 2000.

The unadjusted means shown in Fig 1 do not account for 2 important issues. First, the federal and California postpartum law did not cover the Medicaid population and did not apply to the uninsured. Therefore, it is important to examine changes in LOS by insurance type. Second, there may be changes in other newborn char-

Downloaded from www.aappublications.org/news by guest on December 2, 2020

TABLE 2 **Average Impact of California's Postpartum Legislation on Length of Stay**

Variable	Overall (1)	Insurance Type		
		Medicaid (2)	Non-Medicaid (3)	Uninsured (4)
Prelaw time trend (1991–1997)	−1.0	−1.0	−1.0	−0.48
Change in LOS				
1 y after law (1998), h	9.5	6.8	11.8	5.8
2 y after law (1999), h	11.9	10.0	13.6	9.0
3 y after law (2000), h	13.7	12.1	15.3	10.8

Data for this table exclude preterm, low birth weight, and multiple-birth newborns. Each column represents a separate linear regression in which the dependent variable is LOS in hours. The estimates are coefficients from the linear models and reflect changes in hours of hospital stay. Other covariates in the models included mother's education, age at birth, insurance status, parity, and indicators for infant risk factors at the time of birth, such as trauma, seizures, infection, respiratory problems, any pregnancy or labor complications, and cesarean delivery. $P < .01$ for all estimates.

acteristics over this period that are related to LOS but are not adjusted for. Table 2 reports regression estimates of the impact of the postpartum law on LOS (measured in hours) that control for a variety of maternal and newborn characteristics. We report 4 sets of estimates each for all births, Medicaid births, non-Medicaid births, and uninsured births. Row 1 presents estimates of the prelaw linear time trend in LOS. Rows 2-4 report the deviation in LOS from the prelaw trend 1, 2, and 3 years after the passage of the law.

LOS showed a distinct downward trend in the prelaw years with about an hour decrease in each year. In the first year after the law was passed, there was an average increase of 9.5 hours ($P < .01$) in LOS (Table 2, column 1). In the second and third years, LOS increased by 12 hours ($P < .01$) and 14 hours ($P < .01$), respectively, compared with the prelaw trend. In a separate sensitivity analysis, we estimated the LOS models on the sample of births in years 1995–2000 to account for the flattening in the LOS trend in the immediate prelaw year (1995–1997). Restricting the sample in this manner reduced the effects on LOS in the postlaw years to 5.3, 5.7, and 5.5 hours in years ($P < .01$ for each) 1, 2, and 3, respectively, after the passage of the law.

Columns 2 to 4 in Table 2 report results by insurance type. The prelaw downward trend was more pronounced for insured mothers compared with uninsured mothers ($P < .01$). Although the law did not cover Medicaid and uninsured births, we found that LOS increased significantly for these 2 subpopulations, al-

TABLE 3 **Impact of Postpartum Legislation on LOS by Demographics, Parity, Delivery Type, and Complications During Pregnancy or Delivery**

Regression Sample	Prelaw Linear Time Trend (1)	Change in LOS, h		
		1 y After Law (2)	2 y After Law (3)	3 y After Law (4)
Mother's education				
<High school	−1.0	6.8	9.5	11.5
≥High school	−1.0	10.7[a]	12.9[a]	14.7[a]
Mother's age at child's birth, y				
<18	−0.9	8.0	11.0	13.1
18–35	−1.0	9.2	11.6	13.4
≥35	−1.1	11.4[a]	13.8[a]	15.6
Race				
White	−1.0	11.3[a]	13.4[a]	15.0[a]
Hispanic	−0.9	7.1	9.6	11.6
Parity				
Multiparous	−1.0	8.8	11.1	12.9
Primiparous	−1.0	10.6[a]	13.2[a]	15.0[a]
Delivery type				
Cesarean	−1.9[a]	11.3[a]	15.2[a]	17.9[a]
Vaginal	−0.8	9.0	11.0	12.7
Complications during pregnancy or delivery				
Complications	−1.0	9.6	11.9	13.8
No complications	−0.9	9.0	11.8	13.6

Data for this table exclude preterm, low birth weight, and multiple-birth newborns. Each row represents a separate linear regression where the dependent variable is LOS in hours. The estimates are coefficients from the linear models and reflect changes in hours of hospital stay. Other covariates in the models included mother's education, age at birth, insurance status, parity, and indicators for infant risk factors at the time of birth such as trauma, seizures, infection, respiratory problems, any pregnancy or labor complications, and cesarean delivery. $P < .01$ for all estimates.
[a] For each maternal characteristic, estimates are statistically different from the corresponding estimates for the other subgroups at the 5% level of significance.

Downloaded from www.aappublications.org/news by guest on December 2, 2020

though the increase in LOS for non-Medicaid births was the greatest. Because we found LOS effects for all 3 of the insurance types, we did not restrict our analyses to non-Medicaid births only but instead report estimates for all insurance types combined for the remainder of our analyses.

In Table 3, we report estimates of the impact of the law on LOS by selected demographic characteristics, parity, type of delivery, and whether or not there were certain complications during pregnancy or delivery. There were significant differences in the impact of the law on LOS by mother's education, age, race, parity, and delivery type. After the passage of the law, LOS increased more for mothers with a high school diploma or more education compared with those with less than high school education in each of the 3 postlaw years (P for difference $< .05$ for all 3 years). Mothers >35 years of age experienced a greater increase in LOS in the first 2 years after the passage of the law compared with mothers between 18 and 35 years (P for difference $< .05$ in years 1 and 2 after passage of the law). We did no examine mothers <18 years of age separately because of lack of statistical power. Whites experienced significantly greater increases in LOS in each of the 3 postlaw years compared with Hispanics (P for difference $< .05$). We did not examine other race-ethnicities because of lack of statistical power. Increase in LOS was also greater for primiparous mothers compared with multiparous mothers in each of the 3 postlaw years (P for difference $< .05$ in each year). Increase in LOS was also greater for cesarean births compared with vaginal births (P for difference <.05). There were no statistically significant differences in the effect of the law on LOS between mothers who had pregnancy or delivery complications and those who did not.

Neonatal Readmission

Figure 2 shows trends in neonatal readmissions in California during the 1990s. There was a marginal decline in neonatal readmission rates between 1991 and 1994 from ~29 readmissions per 1000 newborns to 28 readmissions per 1000 newborns. However, this trend reversed between 1994 and 1997. Neonatal readmission rates increased sharply to 33 per 1000 in 1995 and remained thereabouts until 1997. In the postlaw years, there began a decline in neonatal readmission rates, suggesting that the postpartum law might have influenced neonatal readmission rates.

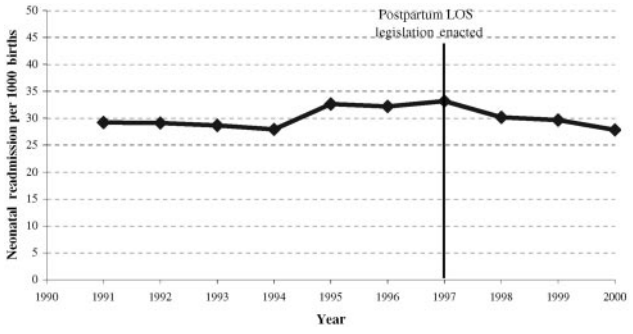

FIGURE 2
Trends in neonatal readmissions in California, 1991–2000. Source: linked database of birth certificate, death certificate, and hospital discharge data from California for the years 1991–2000, which is maintained by OSHPD. Data for this figure exclude preterm, low birth weight, and multiple-birth newborns.

Even after we adjusted the annual neonatal readmission rates for differences in maternal and newborn characteristics, the jump in the rate in 1995 remained (results not shown here), suggesting that there was a change in the time trend in neonatal readmission rates in 1995. As such, fitting a linear time trend through 1991–1997 did not seem appropriate. Instead, we restricted our sample to births in 1995 and beyond for the remainder of the analyses.

Table 4, row 1, shows regression-adjusted estimates of changes in neonatal readmission rates in years 1, 2, and 3 after passage of the law from their prelaw trends using data on births from 1995 and beyond. There was a 1.3% increase in the odds of neonatal readmission in each year during the prelaw years. In 1998, the first year after passage of the law, the odds of neonatal readmission declined 9.3% ($P < .01$) from what a continuation in the prelaw trend would have predicted. The percentage decline in the odds of neonatal readmission was greater in years 1999 (−11.8%; $P < .01$) and 2000 (−19.7%; $P < .01$). In rows 2–4, we report estimates for neonatal readmissions because of jaundice, infection, and respiratory problems. The prelaw trend in neonatal readmissions for each of the 3 causes was positive but not statistically significant. There was a statistically significant increase in jaundice-related readmissions in the first year after the law compared with the prelaw trend (7%; $P < .05$). However, in years 2 and 3 after passage of the law, there was a 5.4% and 11% decline in the odds of jaundice-related readmissions, although it was not statistically significant, even at the 5% level of significance. Changes in infection-related readmissions were statistically insignificant in the first year after the law ($P = .184$). However, there were large declines in the odds of infection-related readmissions in years 1999 (−21.5%; $P < .05$) and 2000 (−30.3%; $P < .05$). The odds of readmissions because of respiratory problems also showed a decline in the postlaw years; however, the decline was not statistically significant.

Table 5 reports estimates of the impact of the law on total neonatal readmissions by selected demographic characteristics, parity, type of delivery, and whether or not there were certain complications during pregnancy or delivery. We find that there was a statistically significant reduction in neonatal readmissions after passage of the law for most subpopulations examined. There were only 2 cases where the effect was not statistically signif-

Downloaded from www.aappublications.org/news by guest on December 2, 2020

TABLE 4 **Impact of Postpartum Legislation on Total and Cause-Specific Neonatal Readmissions**

Regression Sample	Prelaw Linear Time Trend (1)	Percentage Change in Odds		
		1 y After Law (2)	2 y After Law (3)	3 y After Law (4)
Total	1.3	−9.3[a]	−11.8[a]	−19.7[a]
Jaundice	1.5	7.1[b]	−5.4	−10.9
Infection	2.8	−8.7	−21.5[b]	−30.3[b]
Respiratory problems	2.8	−13.8	−6.2	−14.6

Data for this table exclude preterm, low birth weight, and multiple-birth newborns. The results in this table are based on births during 1995–2000. Each row represents a separate logistic regression with neonatal readmissions per 1000 births as the dependent variable. Other covariates in the models included mother's education, age at birth, insurance status, parity, and indicators for infant risk factors at the time of birth, such as trauma, seizures, infection, respiratory problems, any pregnancy or labor complications, and cesarean delivery. The figures in columns 2 to 4 are coefficients from the logistic model and can be interpreted as percentage change in odds of neonatal readmission. The figures in column 1 can be interpreted as the annual growth rate in the odds of neonatal readmission.

[a] $P < .01$.

[b] $P < .05$.

icant at the 5% level. The first was the effect for newborns of mothers without any pregnancy or delivery complications in the first year after passage of the law. However, the effect for this subpopulation became larger and statistically significant in subsequent 2 years. The second was the effect for mothers ≥35 years of age in the second year after passage of the law. However, the effect on older mothers became large and statistically significant in year 3. Unfortunately, because of lack of statistical power, we were not able to reject the hypothesis that the difference in effects was statistically 0 for all of the comparisons of subpopulation by demographic characteristics, parity, delivery type, and complications.

1-Year Mortality

Table 6 reports the regression estimates for total and cause-specific 1-year mortality. There was a steep downward trend in 1-year mortality during the period 1991–1997 when it declined by 8.2 deaths per 1000 births in each year. In the postlaw years, there was no statistically significant divergence from the prelaw trend in either total mortality or mortality because of SIDS or CHMs.

TABLE 5 **Impact of Postpartum Legislation on Neonatal Readmission by Demographics, Parity, Delivery Type, and Complications During Pregnancy or Delivery**

Regression Sample	Prelaw Linear Time Trend (1)	Percentage Change in Odds		
		1 y After Law (2)	2 y After Law (3)	3 y After Law (4)
Mother's education				
<High school	2.2	−9.5[a]	−10.9[b]	−26.1[a]
≥High school	0.7	−9.0[a]	−12.1[a]	−16.5[a]
Mother's age at child's birth, y				
18–35	1.2	−8.8[a]	−11.4[a]	−19.0[a]
≥35	1.3	−13.9[a]	−12.1	−21.8[a]
Race				
White	0.3	−8.1[b]	−9.6[b]	−13.2[b]
Hispanic	2.4	−11.6[a]	−15.1[a]	−27.5[a]
Parity				
Multiparous	1.2	−9.8[a]	−11.3[a]	−20.6[a]
Primiparous	1.3	−8.5[a]	−12.5[a]	−18.5[a]
Delivery type				
Cesarean	0.6	−13.0[a]	−12.0[b]	−20.6[a]
Vaginal	1.4	−8.5[a]	−11.7[a]	−19.4[a]
Complications				
Complicated pregnancy /delivery	1.2	−10.0[a]	−11.5[a]	−19.1[a]
No complications	1.4	−6.6	−12.8[b]	−21.8[a]

Data for this table exclude preterm, low birth weight, and multiple-birth newborns. The results in this table are based on births during 1995–2000. Each row represents a separate logistic regression with neonatal readmissions per 1000 births as the dependent variable. Other covariates in the models included mother's education, age at birth, insurance status, parity, and indicators for infant risk factors at the time of birth, such as trauma, seizures, infection, respiratory problems, any pregnancy or labor complications, and cesarean delivery. The figures in columns 2 to 4 are coefficients from the logistic model and can be interpreted as percentage change in odds of neonatal readmission. The figures in column 1 can be interpreted as the annual growth rate in the odds of neonatal readmission.

[a] $P < .01$.

[b] $P < .05$.

Downloaded from www.aappublications.org/news by guest on December 2, 2020

TABLE 6 **Impact of California's Postpartum Legislation on Total and Cause-Specific 1-Year Mortality**

Regression Sample	Prelaw Linear Time Trend (1)	Percentage Change in Odds		
		1 y After Law (2)	2 y After Law (3)	3 y After Law (4)
Total	−8.2[a]	13.3	9.4	−17.9
SIDS	−6.8	3.3	−1.7	−35.7
CHMs	−16.7	5.0	11.9	20.8

Data for this table exclude preterm, low birth weight, and multiple-birth newborns. The results in this table are based on births during 1995–2000. Each row represents a separate logistic regression with deaths within 1 year per 1000 births as the dependent variable. Other covariates in the models included mother's education, age at birth, insurance status, parity, and indicators for infant risk factors at the time of birth, such as trauma, seizures, infection, respiratory problems, any pregnancy or labor complications, and cesarean delivery. The figures in columns 2 to 4 can be interpreted as percentage change in odds of 1-year mortality. The figures in column 1 can be interpreted as the annual growth rate in the odds of 1-year mortality.

[a] $P < .01$.

Because the estimates for 1-year mortality effects are generally imprecisely estimated in Table 6 because of lack of statistical power, the results for mortality are more tentative. For the same reason, we did not examine differences in mortality effects by demographic characteristics and complications during pregnancy or delivery.

DISCUSSION

This is the first study that examines the effects of postpartum legislation on LOS, neonatal readmission rates, and infant mortality in California. There was a significant increase in postpartum LOS in California after the passage of the state and federal postpartum stay legislations that prohibited insurance plans from limiting coverage for postpartum hospital stay to <48 hours for normal vaginal deliveries and <96 hours for cesarean sections. These results are consistent with previous research that has also examined the LOS effects of postpartum legislation in other states.[6,9,11,18–20]

The current study adds to this literature by examining how the effects of the postpartum legislation on LOS varied with demographics, delivery type, and delivery- and pregnancy-related complications. It is important to examine these differential effects to evaluate whether the legislation had a greater impact on LOS for infants who were at greater risk of adverse outcomes because of early discharge. It is likely that newborns of less educated, older (≥35 years of age), and primiparous mothers would be at greater risk of adverse outcomes because of early discharge. Similarly, newborns of mothers with complicated pregnancies or deliveries and cesarean births might also be at greater risk of adverse outcomes. In a national survey of pediatricians routinely providing care for newborns, a majority of pediatricians reported complications during delivery or pregnancy, maternal age, education, and primiparity as "very important" or "important" in determining discharge readiness.[21] It is also important to evaluate whether disadvantaged populations who face barriers to high quality health care benefited equally from postpartum legislation. The results of the current study show that newborns of whites and more educated mothers experienced a greater increase in LOS after the enactment of postpartum legislation. The evidence on the differential effect of the legislation on LOS of subpopulations that might be at greater risk of adverse outcomes because of early discharge is mixed. The results show no meaningful differences in the effects of the legislation based on complications during delivery or pregnancy. There is some evidence that less educated mothers, who might be at greater risk of adverse outcomes, benefited less. However, infants born to older (≥35 years of age), and primiparous mothers and cesarean births benefited more. It is also possible that contemporaneous changes in other factors, such as primiparity, assisted reproduction, and increased breastfeeding, may have contributed to increased LOS among mothers ≥35 years of age.

The current study also finds that, although the legislation did not apply to uninsured and Medicaid births, it increased postpartum LOS for these populations as well. This is consistent with the notion that physicians have a generalized practice pattern that they apply to all patients, and the legislation changed this practice pattern. A vast literature that has examined spillover effects of managed care on fee-for-service patients also supports the view that physicians might find it cognitively and organizationally difficult to treat patients with different insurance coverage in different ways.[22] The beneficial spillover effects on uninsured and Medicaid could also reflect lack of physician knowledge about the insurance coverage of their patients.

To examine the impact of the law on neonatal readmission rates, we restricted our sample to births that occurred between 1995 and 2000. This is because there was a sharp increase in neonatal readmission rates in 1995, even after adjusting for maternal and newborn characteristics, possibly because of increased patient morbidity as a result of declining LOS or changes in practice guidelines.[23] Similar jumps in neonatal readmissions in 1995 have been documented by studies in other states as well.[10,11] Our findings suggests that there was a

Downloaded from www.aappublications.org/news by guest on December 2, 2020

significant reduction in the odds of neonatal readmissions after the passage of postpartum legislation in California. The reduction in readmission rates mirrored the increase in LOS with the largest decline in readmission rate occurring in the postlaw years with the largest increase in postpartum LOS. Only 2 previous studies have analyzed the effect of postpartum legislation on readmission rates. One study found that postpartum legislation in Ohio led to a modest reduction in readmission rates among Medicaid-insured infants.[11] Another study used data from an HMO in Massachusetts and found no effects of the legislation on readmission rates.[9] There are several reasons why the results of the current study differ from those of previous studies. First, the population of infants and mothers in California differs from the specific subpopulations analyzed in previous studies. For example, our sample includes births with all insurance types and the uninsured, whereas the Ohio study included only Medicaid births, and the Massachusetts study included births from an HMO. In addition, sample sizes across these studies also varied significantly. Second, practice patterns among pediatricians in California might differ from those in previous studies, which were conducted in other states and settings. For example, the Massachusetts study evaluated the effect of the postpartum law in a sample that had an early discharge protocol (1 night stay with a follow-up home visit) before the implementation of the law. Finally, there might be important differences in demographics, providers, hospitals, and other health infrastructure across the studies.

The analysis of cause-specific readmission rates shows significant decline in readmission because of infections. Our results also show sizeable declines in readmission because of jaundice and respiratory problems, although the declines were statistically insignificant. Two previous studies that investigated the effect of postpartum legislation on jaundice-related readmissions also found modest or no effects.[9,11] However, other studies and case reports have documented a positive association between jaundice and shorter LOS.[24,25] Our findings regarding the impact of the law on infant mortality show no statistically significant decline in either overall or cause-specific infant mortality in the postlaw years.

The results of our study should be interpreted in light of its limitations. First, because our study design does not include a control group that was unaffected by the postpartum legislation, we are unable to definitively rule out the effects of changes in other factors related to infant outcomes that may have coincided with passage of the law (eg, changes in service mix, breastfeeding, and physician awareness). However, if passage of the law created a sharp discontinuity in LOS, but other outcome-related factors changed gradually over this period, it may be reasonable to attribute outcomes changes in the immediate postlaw years to the law. Second, one of our outcome measures, neonatal readmissions, is only a proxy for health status, because it also captures clinical practice styles, such as the likelihood of testing and admitting patients with otherwise similar indications. Other studies have documented that changes in readmissions after changes in LOS protocols might be because of ascertainment bias rather than changes in LOS.[10] If postpartum legislation changed clinical practices styles, then the change in readmissions after the legislation would capture both changes in outcomes and changes in practice styles.

ACKNOWLEDGMENTS

This research was funded by National Institute for Child Health and Human Development grant R03-HD43229.

We are grateful to Jesse Malkin and Emmett Keeler for helpful comments on earlier drafts.

REFERENCES

1. Centers for Disease Control and Prevention. Trends in length of stay for hospital deliveries: United States, 1970–1992. *MMWR Morb Mortal Wkly Rep.* 1995;44:335–337
2. Kiely M, Drum MA, Kessel W. Early discharge. Risks, benefits, and who decides. *Clin Perinatol.* 1998;25:539–553, vii–viii
3. Young KT, Davis K, Schoen C. *The Commonwealth Fund Survey of Parents With Young Children*. New York, NY: The Commonwealth Fund; 1996
4. Radetsky M. The newborn at risk for serious infections. *Clin Perinatol.* 1998;25:327–334
5. Hyman DA. Drive-through delivered: is "consumer protection" just what the doctor ordered? *North Carolina Law Rev.* 1998;78 N.C.L. Rev. 5
6. Liu Z, Dow WH, Norton EC. Effect of drive-through delivery laws on postpartum length of stay and hospital charges. *J Health Econ.* 2004;23:129–155
7. Braveman P, Egerter S, Pearl M, Marchi K, Miller C. Problems associated with early discharge of newborn infants: early discharge of newborns and mothers—a critical review of the literature. *Pediatrics.* 1995;96:716–726
8. Malkin JD, Broder MS, Keeler E. Do longer postpartum stays reduce newborn readmission? Analysis using instrumental variables. *Health Services Res.* 2000;35:1071–1091
9. Madden JM, Soumerai SB, Lieu TA, Mandl KD, Zhang F, Ross-Degnan D. Effects of a law against early postpartum discharge on newborn follow-up, adverse events, and HMO expenditures. *N Engl J Med.* 2002;347:2031–2038
10. Madden JM, Soumerai SB, Lieu TA, Mandl KD, Zhang F, Ross-Degnan D. Length-of-stay policies and ascertainment of postdischarge problems in newborns. *Pediatrics.* 2004;113:42–49
11. Meara E, Kotagal UR, Atherton HD, Lieu TA. Impact of early newborn discharge legislation and early follow-up visits on infant outcomes in a state Medicaid population. *Pediatrics.* 2004;113:1619–1627
12. Herrchen B, Gould JB, Nesbitt TS. Vital statistics lined birth/death and hospital discharge record linkage for epidemiological studies. *Comput Biomed Res.* 1997;30:290–305
13. Beebe SA, Britton JR, Britton HL, Fan P, Jepson B. Neonatal mortality and length of hospital stay. *Pediatrics.* 1996;98: 231–235
14. Kessel J, Ward RM. Congenital malformations presenting during the neonatal period. *Clin Perinatol.* 1998;25:351–369
15. Kuehl KS, Loffredo CA, Ferencz C. Failure to diagnose congenital heart disease in infancy. *Pediatrics.* 1999;103:743–747

Downloaded from www.aappublications.org/news by guest on December 2, 2020

16. Malkin JD, Garber S, Broder MS, Keeler E. Infant mortality and early postpartum discharge. *Obstet Gynecol.* 2000;96:183–188
17. Gifford DS, Morton SC, Fiske M, Keesey J, Keeler E, Kahn KL. Lack of progress in labor as a reason for cesarean. *Obstet Gynecol.* 2000;95:589–595
18. Dato V, Ziskin L, Fulcomer M, martin RM, Knoblauch K. Average postpartum length of stay for uncomplicated deliveries: New Jersey. *MMWR Morb Mortal Wkly Rep.* 1995;45: 700–705
19. Udom NU, Betley CL. Effects of maternity-stay legislation on "drive-through deliveries." *Health Aff (Millwood).* 1998;17: 208–215
20. Webb D, Culhane JF, Snyder S, Greenspan J. Pennsylvania's early discharge legislation: effect on maternity and infant lengths of stay and hospital charges in Philadelphia. *Health Serv Res.* 2001;36:1073–1083
21. Britton JR, Baker A, Spino C, Bernstein HH. Postpartum discharge preferences of pediatricians: results from a national survey. *Pediatrics.* 2002;110:53–60
22. Baker LC. Managed care spillover effects. *Annu Rev Public Health.* 2003;24:435–456
23. American Academy of Pediatrics, Provisional Committee for Quality Improvement and Subcommittee on Hyperbilirubinemia. Practice parameter: management of hyperbilirubinemia in the healthy term newborn. *Pediatrics.* 1994; 94(suppl):558–565
24. MacDonald MG. Hidden risks: early discharge and bilirubin toxicity due to glucose 6-phosphate dehydrogenase deficiency. *Pediatrics.* 1995;96:734–738
25. Maisels JM, Baltz RD, Bhutani VK, et al. Neonatal jaundice and kernicterus. *Pediatrics.* 2001;108:763–765

CARE VARIES WIDELY AT TOP MEDICAL CENTERS

"The nation's academic medical centers are renowned for their high-tech expertise and innovative treatments, but they vary widely in how they care for America's sickest patients. A new report by researchers at Dartmouth Medical School says chances that patients with chronic disease will be hospitalized or admitted to an intensive care unit during their last six months of life are as much as five times higher at some major academic hospitals as at others. Similarly, the cost of providing care to such patients over the final two years of their life is more than twice as high at some of the most prestigious medical centers. The Dartmouth investigators say there is no evidence that higher amounts and greater intensity of care lead to better outcomes for patients. They note past studies done at Dartmouth—looking at Medicare patients with heart attacks, hip fractures and colon cancer—that suggest centers with the most high-intensity care actually have slightly higher death rates than those with a lower intensity of care. As a result, the researchers say, the bills for patients with similar illness may be two or three times higher at some prestigious institutions, with no apparent additional benefit and perhaps some risk of harm. The highest number of days spent in the hospital by chronically ill patients in the final six months of life was at New York University Medical Center, with an average of 32.1 days. That compares with 12.9 days, for instance, for patients treated at St. Mary's Hospital, the principal hospital of the Mayo Clinic in Rochester, Minn. At University of California at Los Angeles Medical Center, this type of patient spent an average of 11.4 days in an intensive-care unit during the last six months of life, compared with 3.3 days at University of California at San Francisco Medical Center, which is in the same health-care system."

Winslow R. *Wall Street Journal*. May 16, 2006
Noted by JFL, MD

Downloaded from www.aappublications.org/news by guest on December 2, 2020

Impact of Postpartum Hospital-Stay Legislation on Newborn Length of Stay, Readmission, and Mortality in California

Ashlesha Datar and Neeraj Sood

Pediatrics 2006;118;63
DOI: 10.1542/peds.2005-3044

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/118/1/63
References	This article cites 23 articles, 10 of which you can access for free at: http://pediatrics.aappublications.org/content/118/1/63#BIBL
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): **Fetus/Newborn Infant** http://www.aappublications.org/cgi/collection/fetus:newborn_infant_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://www.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://www.aappublications.org/site/misc/reprints.xhtml

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN®

Downloaded from www.aappublications.org/news by guest on December 2, 2020

PEDIATRICS®
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Impact of Postpartum Hospital-Stay Legislation on Newborn Length of Stay, Readmission, and Mortality in California

Ashlesha Datar and Neeraj Sood

Pediatrics 2006;118;63
DOI: 10.1542/peds.2005-3044

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/118/1/63

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 345 Park Avenue, Itasca, Illinois, 60143. Copyright © 2006 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN®

Downloaded from www.aappublications.org/news by guest on December 2, 2020