OBSTETRICS

Maternal and newborn outcomes with elective induction of labor at term

Vivienne Souter, MD; Ian Painter, PhD; Kristin Sitcov, BS; Aaron B. Caughey, MD, PhD

BACKGROUND: A growing body of evidence supports improved or not worsened birth outcomes with nonmedically indicated induction of labor at 39 weeks gestation compared with expectant management. This evidence includes 2 recent randomized control trials. However, concern has been raised as to whether these studies are applicable to a broader US pregnant population.

OBJECTIVE: Our goal was to compare outcomes for electively induced births at ≥39 weeks gestation with those that were not electively induced.

STUDY DESIGN: We conducted a retrospective cohort study using chart-abstracted data on births from January 1, 2012, to December 31, 2017, at 21 hospitals in the Northwest United States. The study was restricted to singleton cephalic hospital births at 39^{+0}–42^{+6} weeks gestation. Exclusions included previous cesarean birth, missing data for delivery type or gestational week at birth, antepartum stillbirth, cesarean birth without any attempt at vaginal birth, fetal anomaly, gestational diabetes mellitus, prepregnancy diabetes mellitus, and prepregnancy hypertension. The rate of cesarean birth for elective inductions at both 39 and 40 weeks gestation was compared with the rate in all other on-going pregnancies in the same gestational week. Maternal outcomes (operative vaginal birth, shoulder dystocia, 3rd- or 4th-degree perineal laceration, pregnancy-related hypertension, and postpartum hemorrhage) and newborn infant outcomes (macrosomia, 5-minute Apgar <7, resuscitation at delivery, intubation, respiratory complications, and neonatal intensive care unit admission) were also compared between elective inductions and on-going pregnancies at 39 and 40 weeks gestation. Logistic regression modeling was used to produce odds ratios for outcomes with adjustment for maternal age and body mass index. Results were stratified by parity and gestational week at birth. Duration of hospital stay (admission to delivery, delivery to discharge, and total stay) were compared between elective inductions and on-going pregnancies.

RESULTS: A total of 55,694 births were included in the study cohort: 4002 elective inductions at ≥39^{+0} weeks gestation and 51,692 births at 39^{+0}–42^{+6} weeks gestation that were not electively induced. In nulliparous women, elective induction at 39 weeks gestation was associated with a decreased likelihood of cesarean birth (14.7% vs 23.2%; adjusted odds ratio, 0.61; 95% confidence interval, 0.41–0.89) and an increased rate of operative vaginal birth (18.5% vs 10.8%; adjusted odds ratio, 1.8; 95% confidence interval, 1.28–2.54) compared with on-going pregnancies. In multiparous women, cesarean birth rates were similar in the elective inductions and on-going pregnancies. Elective induction at 39 weeks gestation was associated with a decreased likelihood of pregnancy-related hypertension in nulliparous (2.2% vs 7.3%; adjusted odds ratio, 0.28; 95% confidence interval, 0.11–0.68) and multiparous women (0.9% vs 3.5%; adjusted odds ratio, 0.24; 95% confidence interval, 0.15–0.38). Term elective induction was not associated with any statistically significant increase in adverse newborn infant outcomes. Elective induction of labor at 39 weeks gestation was associated with increased time from admission to delivery for both nulliparous (1.3 hours; 95% confidence interval, 0.2–2.3) and multiparous women (3.4 hours; 95% confidence interval, 3.2–3.6).

CONCLUSION: Elective induction of labor at 39 weeks gestation is associated with a decrease in cesarean birth in nulliparous women, decreased pregnancy-related hypertension in multiparous and nulliparous women, and increased time in labor and delivery. How to use this information remains the challenge.

Key words: cesarean birth, induction of labor, multiparous, nulliparous, term

A number of observational studies and systematic reviews have suggested that term induction of labor is not associated with an increase in cesarean birth, may reduce perinatal death and morbidity,[1–3] and may even lower the risk of cesarean birth.[4,5] These recent studies importantly compared induction of labor with expectant management of the pregnancy, not simply spontaneous labor, which is the appropriate clinical comparison.[6] Similarly, systematic reviews of randomized trials beyond the term period (41 and 42 weeks gestation) have found induction of labor to be associated with a lower rate of cesarean birth.[7,8]

In the past 2 years, 2 randomized controlled trials have examined the issue of induction of labor vs expectant management of pregnancy. The 35–39 trial from the United Kingdom reported no increase in the rate of cesarean birth rate in nulliparous women aged 35–39 years who were induced electively at 39 weeks gestation compared with women who were expectantly treated.[9] The ARRIVE (A Randomized Trial of Induction Versus Expectant Management) trial, which was performed in the United States, reported a decrease in cesarean birth in nulliparous women who were induced electively at 39 weeks gestation.[10] However, questions have been raised about the applicability of the findings of the ARRIVE trial to the general US population, particularly given the young median age of trial participants, the low rate of cesarean birth, and the hospitals in the Maternal-Fetal Units Network that participated in the study.

The goal of the current study was to compare maternal and newborn infant outcomes in nulliparous and multiparous births at ≥39 weeks gestation that

Cite this article as: Souter V, Painter I, Sitcov K, et al. Maternal and newborn outcomes with elective induction of labor at term. Am J Obstet Gynecol 2019;220:273.e1-11.

0002-9378/$36.00

https://doi.org/10.1016/j.ajog.2019.01.223

AJOG at a Glance

Why was this study conducted?

This multicenter cohort study was performed to evaluate outcomes after term elective induction of labor at ≥39 weeks.

Key findings

Nulliparous women who gave birth at 39 weeks gestation after elective induction of labor had decreased odds of cesarean birth, increased odds of operative vaginal birth, and increased time from hospital admission to delivery. Gestational hypertension/preeclampsia was decreased in both electively induced multiparous and nulliparous women. Elective induction at 39 or 40 weeks gestation was not associated with any statistically significant increase in the rate of adverse newborn infant outcomes.

What does this add to what is known?

Our results are consistent with those of the ARRIVE trial that showed a decrease in cesarean birth that is associated with elective induction of labor at 39 weeks gestation in nulliparous women.

underwent elective induction of labor (induction without a medical indication) compared with pregnancies that were managed expectantly.

Material and Methods

This study used chart-abstracted data on consecutive births from 21 hospitals that participated in a quality initiative in the Northwest United States for all or part of the study period (January 1, 2012, to December 31, 2017). The study was restricted to singleton cephalic hospital births at 39^{+0}–42^{+6} weeks gestation. Exclusions included previous cesarean birth, cesarean birth without any attempt at vaginal birth, missing data for delivery type or gestational week at birth, antepartum stillbirth, fetal anomaly, gestational diabetes mellitus, prepregnancy diabetes mellitus, and prepregnancy hypertension.

The indication for induction of labor was obtained from a single field in the database. If the indication for induction in this field was recorded as either "Elective" or "Not medically indicated," then the induction of labor was categorized as "elective" for the purposes of the study. Database abstractors were instructed to categorize induction of labor as "elective" if the indication for induction of labor stated in the medical record was "elective" and to record the indication for induction of labor as "not medically indicated" if the only stated indication for induction in the medical record was any of the following items: history of fast labor, distance from hospital, suspected macrosomia, psychosocial, maternal discomfort, advanced cervical dilation with group B streptococcus negative status, or <41 weeks gestation with no medical indication for induction. Abstractors were directed to the admission history and physical in the medical record to obtain this information. Any induction of labor at ≥41 weeks gestation or ruptured membranes at the time of admission was considered to be indicated medically. There was no further recategorization of "soft indications" to include them in the elective induction group in the study.

The gestational age at birth was based on the clinical estimated date of confinement (EDC) stated in the medical record. Data were collected on whether the EDC was calculated with the use of the last menstrual period, the use of ultrasound scans, the use of other data, or if the source of the EDC was not documented in the medical record. If the EDC was determined with ultrasound scanning, abstractors were instructed to record the gestational age (in weeks) at which this ultrasound scan was performed. The Obstetrical Care Outcomes Assessment Program (OB COAP) did not stipulate how participating sites determined gestational age or whether they followed the American College of Obstetricians and Gynecologists guidelines for determining gestational age, which was the method used to determine gestational age in the ARRIVE trial.[10] The ARRIVE trial also excluded pregnancies for which the first ultrasound scan was at >20 weeks 6 days gestation. No births were excluded from our study based on the method used to determine EDC.

The primary outcome, cesarean birth, was evaluated for those who gave birth at 39 (39^{+0}–39^{+6} weeks) and 40 weeks gestation (40^{+0}–40^{+6} weeks) after elective induction of labor compared with all other pregnancies from the same gestational week that were not induced electively in that week (on-going pregnancies) and delivered either in the same week or future gestational weeks. A sensitivity analysis was also performed to compare cesarean birth rates with the use of a different comparator group: ongoing pregnancies in the next or future gestational weeks.

The difference in the median gestational age at birth (in days) was compared between births at 39 and 40 weeks gestation that were induced electively and the respective on-going pregnancies group. Additional secondary maternal outcomes included operative vaginal birth, shoulder dystocia, 3rd- or 4th-degree perineal laceration, pregnancy-related hypertension (preeclampsia or gestational hypertension), and postpartum hemorrhage. Newborn infant outcomes included 5-minute Apgar score <7, intubation at delivery, respiratory complications, macrosomia (birthweight >4500 g), and neonatal intensive care unit (NICU) admission. Respiratory complications included any newborn infant respiratory complication that was recorded in the medical record and were not limited to specific diagnoses or degrees of severity

Bishop score (but not its individual components) was available only for women who underwent elective induction of labor at a subset of participating hospitals and was not provided systematically by all sites. Cervical effacement and dilation at the first cervical examination that was recorded on admission to labor and delivery were available. For

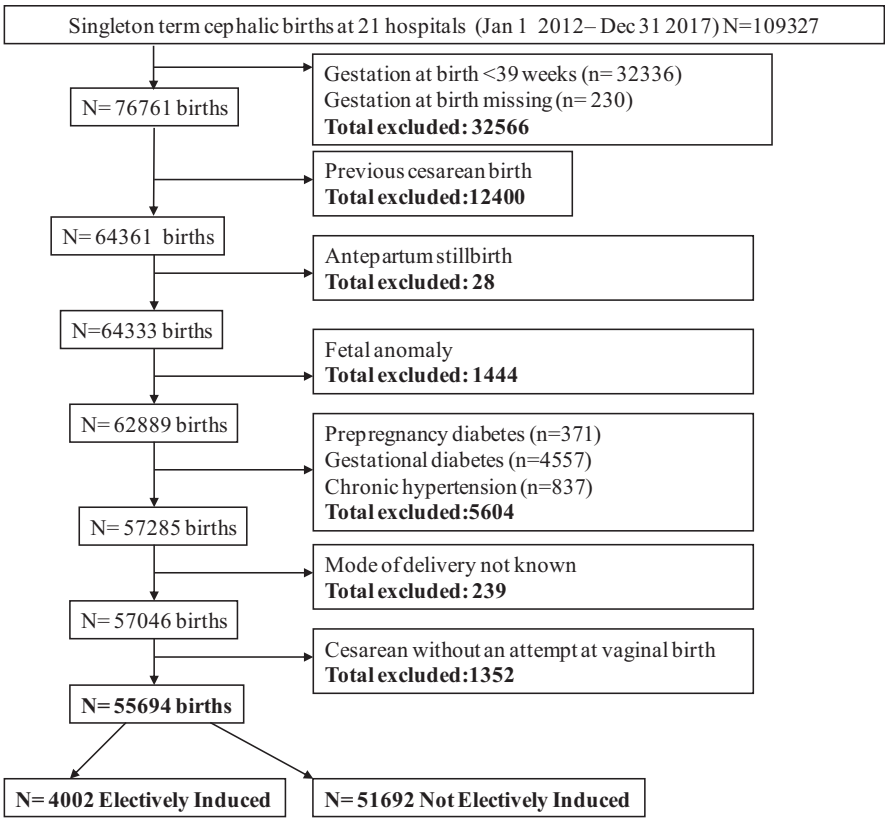
women who underwent induction of labor, this first examination reflected a prelabor cervical examination. For women who were not induced, the first cervical examination most likely reflected early or established labor. Cervical dilation was compared for women who underwent elective induction, women who underwent medically indicated induction, and women in spontaneous labor. A sensitivity analysis was performed to understand the impact of dilation at admission on the cesarean birth rate. Mixed effect logistic regression modeling was used to calculate odds ratios for outcomes, with adjustment for maternal age and body mass index. The hospital was included as a random effect to account for possible clustering with the hospital. Adjusted odds ratios with 95% confidence intervals are presented. All models use the on-going pregnancies group as the referent group. Results are stratified by parity and gestational week at birth. Sensitivity analyses were conducted with the use of a subset of hospitals with provider information to assess the extent of clustering within providers by comparing results of the logistic regression models with and without providers included as random effects.

The median time and interquartile range (hours) from admission to delivery, delivery to discharge, and admission to discharge in the mother and the median length of hospital stay for the baby were calculated. These times were compared between elective inductions and on-going pregnancies with the use of the Hodges-Lehmann estimate of the median pairwise distance.

The data for this retrospective cohort study came from the Foundation for Health Care Quality's OB COAP, which is an on-going multicenter clinician-led, quality improvement collaborative. Clinical data on consecutive births are collected routinely from the medical record and capture a wide range of variables that include maternal demographics, prepregnancy health, pregnancy complications, labor course, birth, and postnatal outcomes for both mothers and babies. OB COAP has been described in detail previously.[11] Data are entered into a cloud-based, standardized data tool by individually trained abstractors, who include obstetric providers, nurses, and healthcare data and quality improvement specialists. At sites with electronic medical records, selected fields are uploaded directly from the medical record. Data undergo real-time data quality and validation checks that are performed both at the site and at the aggregate level. Ad hoc quality checks are also conducted on a routine basis by OB COAP staff. Monthly data manager educational sessions and unlimited access to OB COAP staff for education and support are available. Volumes submitted to OB COAP are audited annually against billing records with a minimum of 90% agreement required.

The Western Institutional Review Board determined in 2015 that OB COAP is not engaged in human subjects research and does not require institutional review board review.

FIGURE
Study cohort



Flow diagram of exclusions and final analytic sample.

Souter et al. Elective induction at term. Am J Obstet Gynecol 2019.

Results

During the study period, 109,327 singleton term cephalic births were entered into the OB COAP database. After exclusions, a total of 55,694 births were included in the study cohort: 4002 elective inductions and 51,692 expectantly managed births at 39-42^{+6} weeks gestation (Figure). This led to comparisons of 2318 women with an elective induction of labor at 39 weeks gestation vs 53,376 women who were treated expectantly at ≥39 weeks gestation. Similarly, there were 1684 women at 40 weeks gestation with an elective induction of labor compared with 30,715 women who were treated expectantly.

The mean maternal age was 29.8 years in the 39-week elective induction group and 29.3 years in the group who were not electively induced (Table 1). Elective induction was associated with multiparity, older maternal age, and higher body

TABLE 1
Characteristics of the study cohort

Variable	Elective induction at 39 weeks gestation (n=2318), n (%)	On-going pregnancies (n=53,376), n (%)	*P* value	Elective induction at 40 weeks gestation (n=1684), n (%)	On-going pregnancies (n=30,715), n (%)	*P* value
Demographic characteristics						
Age at admission, y			<.001			<.001
<20	47 (2)	2,344 (4.4)		41 (2.4)	1,324 (4.3)	
20–34	1807 (78)	40,972 (76.8)		1280 (76)	23,591 (76.8)	
35–39	359 (15.5)	7,764 (14.5)		280 (16.6)	4,505 (14.7)	
≥40	83 (3.6)	1,432 (2.7)		66 (3.9)	772 (2.5)	
Missing	22 (0.9)	864 (1.6)		17 (1)	523 (1.7)	
Race and ethnicity			<.001			<.001
White, non-Hispanic	1534 (66.2)	27,344 (51.2)		1037 (61.6)	16,268 (53)	
Black, non-Hispanic	43 (1.9)	1,877 (3.5)		30 (1.8)	1,196 (3.9)	
Hispanic	357 (15.4)	8,336 (15.6)		278 (16.5)	4,290 (14)	
Asian or Pacific Islander	140 (6)	7,548 (14.1)		147 (8.7)	4,002 (13)	
American Indian or Alaska Native	38 (1.6)	616 (1.2)		27 (1.6)	310 (1)	
Other	73 (3.1)	2,031 (3.8)		54 (3.2)	1,134 (3.7)	
Missing	133 (5.7)	5,624 (10.5)		111 (6.6)	3,515 (11.4)	
Health insurance			<.001			<.001
Commercial	1078 (46.5)	25,398 (47.6)		805 (47.8)	14,936 (48.6)	
Not commercial	916 (39.5)	18,907 (35.4)		641 (38.1)	10,363 (33.7)	
Missing	324 (14)	9,071 (17)		238 (14.1)	5,416 (17.6)	
Prepregnancy health						
Body mass index, kg/m^2			<.001			<.001
<30	1016 (43.8)	24,917 (46.7)		705 (41.9)	13,871 (45.2)	
30–39	1017 (43.9)	20,350 (38.1)		751 (44.6)	12,098 (39.4)	
≥40	190 (8.2)	3,387 (6.3)		152 (9)	1,983 (6.5)	
Missing	95 (4.1)	4,722 (8.8)		76 (4.5)	2,763 (9)	

Souter et al. Elective induction at term. Am J Obstet Gynecol 2019.

(continued)

mass index compared with women who were treated expectantly. In all, 49.1% of the cohort was nulliparous, and 50.9% was multiparous. The cesarean birth rate was 23.2% in nulliparous women and 3.3% in multiparous women. Labor was induced electively in 4002 women or 7.7% of the study cohort.

At 39 weeks gestation, the cesarean rate in electively induced nulliparous women was 14.7% vs 23.2% (adjusted odds ratio, 0.61; 95% confidence interval, 0.41–0.89) in expectantly treated nulliparous women (Table 2). At 40 weeks gestation, the cesarean rates that compared elective induction of labor with expectant management were 24.0% vs 26.4% (adjusted odds ratio, 0.90; 95% confidence interval, 0.70–1.17) in nulliparous women. Among multiparous women, there was no statistically significant difference in cesarean rates with elective induction at either 39 or 40 weeks gestation. Results did not appreciably change when the analysis used clustering on providers in the subset of hospitals for which provider identification was available.

There was a 5-day difference in the median gestational age at birth for nulliparous women who were induced electively at 39 weeks gestation compared with expectantly managed nulliparous pregnancies. This difference was 4 days in multiparous women.

The sensitivity analysis that was performed with on-going pregnancies in the next gestational week as the comparator group (instead of on-going pregnancies in the same gestational week) showed a statistically significant decrease in

TABLE 1
Characteristics of the study cohort *(continued)*

Variable	Elective induction at 39 weeks gestation (n=2318), n (%)	On-going pregnancies (n=53,376), n (%)	*P* value	Elective induction at 40 weeks gestation (n=1684), n (%)	On-going pregnancies (n=30,715), n (%)	*P* value
Pregnancy characteristics						
Parity			<.001			<.001
Nulliparous	218 (9.4)	27,533 (51.6)		342 (20.3)	17,765 (57.8)	
Multiparous	2100 (90.6)	25,843 (48.4)		1342 (79.7)	12,950 (42.2)	
Prenatal care: incomplete/absent prenatal care	18 (0.8)	1,102 (2.1)		29 (1.7)	634 (2.1)	.43
Ultrasound dating						
Ultrasound-based dating	479 (41.1)	9,032 (34.1)	<.001	321 (39.1)	5,001 (33.4)	<.001
Dating ultrasound $<21^{+0}$ wk gestation	431(95.8)	7,576 (91.0)	<.001	271 (90)	4,153 (90.1)	<.001
Induction of labor	2318 (100)	14,407 (27.0)	<.001	1684 (100)	9,411 (30.6)	<.001
Epidural	1895 (82.0)	38,407 (72.2)	<.001	1388 (82.6)	22,734 (74.2)	
Hospital level of neonatal care			<.001			<.001
I	438 (18.9)	7476 (14)		257 (15.3)	4242 (13.8)	
II	204 (8.8)	8880 (16.6)		170 (10.1)	5302 (17.3)	
III-IV	1676 (72.3)	37020 (69.4)		1257 (74.6)	21171 (68.9)	

Souter et al. Elective induction at term. Am J Obstet Gynecol 2019.

cesarean birth at 39 and 40 weeks gestation for nulliparous women who underwent elective induction (Supplemental Table 1). It also showed a statistically significant decrease in cesarean birth at 39 weeks gestation in multiparous women.

Elective induction of labor at 39 weeks gestation was associated with an increase in the rate of operative vaginal birth (forceps or vacuum) in nulliparous women (18.5% vs 10.8%; adjusted odds ratio, 1.8; 95% confidence interval, 1.28−2.54). Term elective induction both at 39 and 40 weeks gestation was also associated with a decrease in hypertensive disorders of pregnancy (preeclampsia/gestational hypertension) irrespective of parity (Table 3). Elective induction at 39 or 40 weeks gestation was not associated with any statistically significant increases in the rates of adverse newborn infant outcomes. Statistically significant decreases were observed for NICU admission in nulliparous women who were induced at 39 weeks gestation, neonatal respiratory complications in nulliparous women who were induced at 40 weeks gestation, and neonatal intubation in multiparous women who were induced at 39 weeks gestation (Table 4).

TABLE 2
Cesarean birth rates in elective inductions and on-going pregnancies

Cesarean birth	Week at birth	Elective inductions,% (n)	On-going pregnancies,[a] % (n)	Adjusted odds ratio[b]	95% Confidence interval	*P* value
Nulliparous	39	14.7 (218)	23.2 (27,533)	0.61	0.41−0.89	.011
	40	24.0 (342)	26.4 (17,765)	0.90	0.70−1.17	.443
Multiparous	39	2.8 (2100)	3.4 (25,843)	0.83	0.64−1.09	.190
	40	4.3 (1342)	3.9 (12,950)	1.13	0.85−1.51	.394

[a] The referent group is "on-going pregnancies" and includes all pregnancies that were not elective inductions in the same gestational week; [b] Adjusted for maternal age and body mass index.
Souter et al. Elective induction at term. Am J Obstet Gynecol 2019.

TABLE 3
Maternal outcomes for elective inductions and on-going pregnancies

Outcome	Elective inductions, %	On-going pregnancies, %[a]	Adjusted odds ratio[b]	95% Confidence interval	*P* value
At 39 weeks gestation					
Nulliparous	n=218	n=27,533			
Operative vaginal birth	18.5	10.8	1.80	1.28-2.54	<.01
Shoulder dystocia	1.8	2.2	0.77	0.29-2.07	.602
Preeclampsia/gestational hypertension	2.2	7.3	0.28	0.11-0.68	<.01
3rd/4th-Degree laceration	4.8	5.1	0.94	0.51-1.73	.837
Postpartum hemorrhage	4.0	4.3	1.06	0.54-2.07	.861
Multiparous	n=2100	n=25,843			
Operative vaginal birth	3.1	3.4	0.85	0.66-1.10	.207
Shoulder dystocia	3.2	3.6	0.89	0.69-1.14	.352
Preeclampsia/gestational hypertension	0.9	3.5	0.24	0.15-0.38	<.001
3rd/4th-Degree laceration	0.7	1.0	0.66	0.38-1.13	.127
Postpartum hemorrhage	2.7	2.7	1.01	0.76-1.33	.957
At 40 weeks gestation					
Nulliparous	n=342	n=17,765			
Operative vaginal birth	10.8	11.1	0.98	0.70-1.39	.916
Shoulder dystocia	2.8	2.2	1.23	0.65-2.33	.526
Preeclampsia/gestational hypertension	1.4	6.0	0.22	0.09-0.54	<.01
3rd/4th-Degree laceration	5.4	5.3	1.01	0.63-1.62	.961
Postpartum hemorrhage	2.3	4.5	0.61	0.30-1.24	.172
Multiparous	n=1342	n=12,950			
Operative vaginal birth	4.3	3.7	1.12	0.84-1.49	.430
Shoulder dystocia	4.8	4.1	1.15	0.88-1.50	.298
Preeclampsia/gestational hypertension	0.7	2.8	0.21	0.11-0.41	<.001
3rd/4th-Degree laceration	1.4	1.0	1.36	0.83-2.23	.217
Postpartum hemorrhage	3.2	3.1	1.08	0.78-1.49	.655

[a] The referent group is "on-going pregnancies" and includes all pregnancies that were not elective inductions in the same gestational week; [b] Adjusted for maternal age and body mass index.
Souter et al. Elective induction at term. Am J Obstet Gynecol 2019.

Bishop score was available for 43.0% of nulliparous women (241/560) and 55.8% of multiparous women (1921/3442) who were induced electively. For elective inductions with a Bishop score available, the median score was 8 in both nulliparous and multiparous women, and the score was <5 in 15.4% of nulliparous women and 9.1% of multiparous women.

As expected, spontaneously laboring women had greater cervical dilation and effacement on the first cervical examination compared with women who were admitted for induction of labor (Supplemental Table 2). For women who underwent elective induction of labor, median cervical effacement was 75% in nulliparous women and 70% in multiparous women. Median cervical dilation was 3 cm in both nulliparous and multiparous women who underwent elective induction. Women who were induced for a medical indication tended to have less favorable cervical examinations. The sensitivity analysis that adjusted for dilation at admission did not change the estimated odds ratios for cesarean birth materially.

In nulliparous women, elective induction of labor at 39 weeks gestation was associated with an increase in the admission-to-delivery time, a decrease in the delivery-to-discharge time, and a decrease in the total duration of the hospital stay for the mother and the baby

TABLE 4
Newborn infant outcomes for elective inductions and on-going pregnancies

Outcome	Rate in elective inductions, %	On-going pregnancies,%[a]	Adjusted odds ratio[b]	95% Confidence interval	*P* value
At 39 weeks gestation					
Nulliparous	n=218	n=27,533			
5-minute Apgar <7	0	1.7	—	—	—
Intubation	0.4	0.7	0.65	0.09–4.72	.667
Respiratory complication[c]	1.3	2.9	0.45	0.15–1.39	.167
Neonatal intensive care unit admission	1.8	5.6	0.37	0.14–0.98	.046
Macrosomia[d]	7.5	5.5	1.58	0.92–2.72	.097
Multiparous					
5-minute Apgar <7	0.6	0.6	1.08	0.61–1.91	.797
Intubation	0.1	0.2	0.46	0.46–0.46	<.001
Respiratory complication[c]	1.0	1.4	0.83	0.53–1.30	.425
Neonatal intensive care unit admission	1.9	2.8	0.85	0.61–1.17	.315
Macrosomia[d]	4.5	6.0	0.91	0.72–1.14	.406
At 40 weeks gestation					
Nulliparous	n=342	n=17,765			
5-minute Apgar <7	0.6	1.8	0.28	0.07–1.16	.079
Intubation	0	0.9	—	—	—
Respiratory complication[c]	1.8	3.1	0.33	0.12–0.90	.029
Neonatal intensive care unit admission	3.7	5.9	0.71	0.40–1.25	.239
Macrosomia[d]	4.3	5.9	0.82	0.47–1.44	.486
Multiparous					
5-minute Apgar <7 score	0.7	0.6	1.19	0.61–2.31	.608
Intubation	0	0.3	—	—	—
Respiratory complication[c]	1.0	1.4	0.82	0.47–1.45	.500
Neonatal intensive care unit admission	1.5	2.9	0.68	0.44–1.07	.093
Macrosomia[d]	4.6	7.0	0.81	0.61–1.07	.139

[a] The referent group is "on-going pregnancies" and includes all pregnancies that were not elective inductions in the same gestational week; [b] Adjusted for maternal age and body mass index; [c] Any newborn infant respiratory complication; [d] Birthweight >4500 g.

Souter et al. Elective induction at term. Am J Obstet Gynecol 2019.

(Table 5). For multiparous women, elective induction of labor at 39 and 40 weeks gestation was associated with an increased admission-to-delivery time, a decreased delivery-to-discharge time for the mother, and no statistically significant difference in total length of maternal hospital stay.

Comment

Principal findings

Consistent with the recent ARRIVE trial results,[10] our study suggests that elective induction of labor at 39 weeks gestation is associated with a decrease in cesarean birth for nulliparous women and a decrease in pregnancy-related hypertension for both nulliparous and multiparous women. Induction of labor at 39 weeks gestation was associated with a statistically significant increase in the time in labor and delivery for both multiparous and nulliparous women, but a decrease in the total hospital stay for nulliparous women.

Although our study showed an association between term elective induction and decreased risk for hypertensive disorders of pregnancy in multiparous women, it did not show an association between term elective induction of labor and cesarean birth in multiparous women when compared with on-going pregnancies in the same gestational week. This finding is important because most recent studies have focused on nulliparous women; our study suggests that the implications of term elective

TABLE 5
Median length of hospital stay

Length of stay in hospital	Elective inductions hours, n (IQR)	On-going pregnancies hours, n (IQR)	Difference in stay hours	95% Confidence interval	*P* value[a]
At 39 weeks gestation					
Nulliparous					
Admit to delivery	13.5 (10.1–20.8)	13.0 (8.2–19.6)	1.3	0.2–2.3	<.05
Delivery to discharge (mother)	29.6 (24.5–41.9)	38.8 (29.4–50.3)	−6.5	−3.5 to −9.5	<.001
Total (mother)	45.1 (35.1–67.0)	53.5 (40.9–69.1)	−4.9	−9.3 to −0.9	<.05
Total (baby)	30.2 (24.7–42.8)	40.2 (30.1–52.8)	−7.2	−4.2 to −10.5	<.001
Multiparous					
Admit to delivery	9.2 (7.0–12.5)	6.0 (3.0–10.1)	3.4	3.2–3.6	<.001
Delivery to discharge (mother)	25.9 (23.6–36.0)	29.8 (25.3–37.3)	−2.5	−2.9 to −2.0	<.001
Total (mother)	35.7 (31.7–48.8)	36.6 (31.4–46.1)	0.4	−0.2–0.9	.24
Total (baby)	26.2 (23.8–37.6)	30.5 (25.4–38.7)	−2.6	−3.1 to −2.1	<.001
At 40 weeks gestation					
Nulliparous					
Admit to delivery	14.4 (11.1–19.3)	14.0 (9.0–20.8)	0.8	0.0–1.6	.06
Delivery to discharge (mother)	39.1 (27.7–49.2)	39.3 (29.8–51.3)	−1.7	−4.0–0.5	.13
Total (mother)	54.9 (45.2–71.0)	54.9 (42.0–71.3)	0.2	−2.8–3.2	.91
Total (baby)	41.4 (29.7–51.6)	40.8 (30.6–53.7)	−1.2	−3.6–1.3	.33
Multiparous					
Admit to delivery	9.5 (7.1–12.7)	6.3 (3.2–10.6)	3.2	3.0–3.5	<.001
Delivery to discharge (mother)	25.8 (23.4–35.6)	29.9 (25.2–37.3)	−2.7	−3.2 to −2.1	<.001
Total (mother)	35.5 (31.7–47.7)	36.9 (31.6–47.0)	−0.2	−0.9–0.5	.61
Total (baby)	26.1 (23.7–38.0)	30.5 (25.4–38.7)	−2.6	−3.2 to −2.0	<.001

[a] The Hodges-Lehmann estimate of the median pairwise distance was used to compare the difference in stay between elective inductions and on-going pregnancies.

Souter et al. Elective induction at term. Am J Obstet Gynecol 2019.

induction for mode of delivery are different, dependent on parity.

Strengths and weaknesses

Although our study does potentially deal with some of the issues of concern in the ARRIVE trial, such as the inclusion of nonacademic community hospitals, the study has several limitations. As a retrospective cohort study, the issue of confounding bias is impossible to eliminate, even with multivariable statistical techniques. The 14.7% cesarean birth rate and the relatively low median time on labor and delivery (13.5 hours) for nulliparous women who underwent elective induction at 39 weeks gestation suggest that there may have been factors in the elective induction group (eg, favorable outpatient Bishop score) that could have lowered the threshold for induction and in turn have increased the likelihood of vaginal birth. Although we were able to evaluate a range of maternal and newborn infant outcomes, we do not have data on the indication for admission to the NICU, the severity of respiratory complications, or respiratory diagnoses. Additionally, we could not control for variation in provider practices that could have led to different treatment approaches in women who were induced electively compared with women who were not. However, we did conduct the analysis clustering by provider and did not find any significant changes in the outcomes. It is also noted that our study captured only short-term maternal and newborn infant outcomes and that the long-term implications of term elective induction of labor are unknown.

Comparison of the findings of the current study with those of previous studies

Our study findings are consistent with previous studies that used the methodologic approach of induction of labor vs expectant management and that found lower rates of cesarean delivery and perinatal complications with elective induction of labor. However, our study differs from many of the previous retrospective cohort studies of term elective induction of labor in several ways. The data were extracted directly from the medical record

rather than from routinely collected/administrative data such as that used by others.[1,2,4] Additionally, the elective induction group in our study was identified through the indication for induction of labor in the medical record, rather than by the presence of induction of labor in the absence of any discernable medical indication for induction or contraindication to induction. [1,2,4] We were also able to exclude cesarean births (both scheduled and emergency) where there was no attempt at vaginal birth.

Aside from the obvious inclusion of multiparous and nulliparous women, the current study population differed from that of the ARRIVE trial in a number of ways. In our study population, the mean maternal age was greater (29 years); the births were at level I, II, and III-IV hospitals with no unifying policy on induction of labor, and there were higher rates of Asian and white women and fewer black and Hispanic women, which suggests that the findings of the ARRIVE trial are potentially applicable to a wider population.

Clinical implications

The question remains as to what to do with this information. For women who are concerned about the risks of prolonging pregnancy to >39 weeks gestation, elective induction seems to be a reasonable option and does not appear to increase the cesarean delivery rate. It may also have favorable impacts on some other maternal and newborn infant outcomes, although the possibility of unintended consequences for the mother and baby that we have not considered or measured cannot be excluded. At a population level, though, offering routine elective induction of labor is likely not feasible. Such a process potentially would lead to overcrowded labor and delivery units that may not have adequate space or staffing for patients with medical complications of pregnancy. Additionally, our study and the ARRIVE trial both demonstrated an increased amount of time on labor and delivery for the women who underwent elective induction. This likely would lead to increased costs; therefore, the economic impact of term elective induction needs further evaluation.

In addition, despite the finding of lower cesarean birth rates, routine elective induction of labor at 39 weeks gestation may not be a practical strategy for the reduction of the cesarean birth rate. The ARRIVE trial suggested that 1 cesarean birth may be avoided for every 28 births in low-risk nulliparous women who are planning elective induction of labor at 39 weeks gestation. However, considering the increase in the rate of induction of labor in singleton pregnancies from approximately 10% in 1990 to 26% in 2017 and the concurrent increase in the cesarean birth rate from approximately 22−32%, it is questionable whether further increases in the frequency of induction alone are likely to decrease the cesarean birth rate significantly.[12,13]

It is also uncertain how most consumers of maternity care feel about elective induction of labor. Physiologic birth is ranked highly in international studies about what women want for childbirth[14]; in a survey from California that reported results from 2539 women who had recently given birth in hospital, 74% of the women agreed with the statement that "childbirth is a process that should not be interfered with unless medically necessary."[15] For such individuals, even a routine offering of elective induction of labor may feel coercive from the medical establishment. Thus, it is imperative for providers to understand patient preferences regarding not only mode of delivery but also of interventions in pregnancy.[16]

Conclusions

Elective induction at 39 weeks gestation adds to the growing number of optional interventions in pregnancy. These interventions may be very beneficial for some, add unnecessary intervention and risk for others, and require considerable resources in an already expensive healthcare system. More accurate assessment of risk and benefits of interventions for individuals, rather than the population as a whole, may be the way forward in supporting women in their choices for childbirth. Additional assessment of the impact and outcomes of this intervention in a range of settings and the economic impact are imperative before elective induction of labor becomes offered routinely. ■

References

1. Stock SJ, Ferguson E, Duffy A, Ford I, Chalmers J, Norman JE. Outcomes of elective induction of labour compared with expectant management: population based study. BMJ 2012;344:e2838.
2. Darney BG, Snowden JM, Cheng YW, et al. Elective induction of labor at term compared with expectant management: maternal and neonatal outcomes. Obstet Gynecol 2013;122:761–9.
3. Gibson KS, Waters TP, Bailit JL. Maternal and neonatal outcomes in electively induced low-risk term pregnancies. Am J Obstet Gynecol 2014;211:249.e1–16.
4. Cheng YW, Kaimal AJ, Snowden JW, Nicholson JM, Caughey AB. Induction of labor compared to expectant management in low risk women and associated perinatal outcomes. Am J Obstet Gynecol 2012;207:502.
5. Wood S, Cooper S, Ross S. Does induction of labour increase the risk of caesarean section? A systematic review and meta-analysis of trials in women with intact membranes. BJOG 2014;121:674–85.
6. Caughey AB, Nicholson JM, Cheng YW, Lyell DJ, Washington AE. Induction of labor and cesarean delivery by gestational age. Am J Obstet Gynecol 2006;195:700–5.
7. Caughey AB, Sundaram V, Kaimal AJ, et al. Systematic review: elective induction of labor versus expectant management of pregnancy. Ann Intern Med 2009;151:252–63.
8. Middleton P, Shepherd E, Crowther CA. Induction of labour for improving birth outcomes for women at or beyond term. Cochrane Database Syst Rev 2018;5:CD004945.
9. Walker KF, Bugg GJ, Macpherson M, et al. Randomized trial of labor induction in women 35 years of age or older. N Engl J Med 2016;374:813–22.
10. Grobman WA, Rice MM, Reddy UM, et al. Labor induction versus expectant management in low-risk nulliparous women. N Engl J Med 2018;379:513–23.
11. Kauffman E, Souter VL, Katon JG, Sitcov K. Cervical dilation on admission in term spontaneous labor and maternal and newborn outcomes. Obstet Gynecol 2016;127:481–8.
12. Zhang J1, Yancey MK, Henderson CE. US national trends in labor induction, 1989-1998. J Reprod Med 2002;47:120–4.
13. Martin JA, Hamilton BE, Osterman MJK, et al. Births: final data for 2017. National Vital Statistics Reports. Available at: https://www.cdc.gov/nchs/data/nvsr/nvsr67/nvsr67_08-508.pdf. Accessed September 2018.

14. Downe S, Finlayson K, Oladapo O, Bonet M, Gülmezoglu AM. What matters to women during childbirth: a systematic qualitative review. PLoS One 2018;13:e0194906.

15. Sakala C, Declercq ER, Turon JM, et al. Listening to mothers in California: a population-based survey of women's childbearing experiences, full survey report. Washington (DC): National Partnership for Women & Families; 2018.

16. Sparks TN, Yeaton-Massey A, Granados JM, Handler SJ, Meyer M, Caughey AB. How do maternal views of delivery outcomes vary by demographics and preferred mode of delivery? Am J Perinatol 2015;32:741–6.

Author and article information

From the Department of Health Services, School of Public Health, University of Washington, Seattle, WA (Drs Souter and Painter); Foundation for Health Care Quality, Seattle, WA (Drs Souter and Painter and Ms Sitcov); Department of Obstetrics & Gynecology, Oregon Health & Science University, Portland, OR (Dr Caughey).

Received Nov. 9, 2018; revised Jan. 8, 2019; accepted Jan. 21, 2019.

The Foundation for Health Care Quality is a 501(c)(3) non-profit organization supported by membership dues from the participants in its programs.

The authors report no conflict of interest.

Corresponding author: Vivienne Souter, MD. vsouter@qualityhealth.org

SUPPLEMENTAL TABLE 1

Cesarean birth rates in elective inductions and "on-going pregnancies" in the next gestational week (births in the next gestational week and beyond)

Cesarean birth	Week at birth	Elective inductions, %	On-going pregnancies in the next gestational week, %[a]	Adjusted odds ratio[b]	95% Confidence interval	*P* value
Nulliparous	39	14.7	26.4	0.53	0.36-0.77	.001
	40	24.0	33.0	0.69	0.53-0.90	.006
Multiparous	39	2.8	3.9	0.73	0.55-0.96	.025
	40	4.3	5.6	0.78	0.57-1.06	.111

[a] The referent group of "on-going pregnancies" includes all births in the next gestational week and beyond; [b] Adjusted for maternal age and body mass index.

Souter et al. Elective induction at term. Am J Obstet Gynecol 2019.

SUPPLEMENTAL TABLE 2

Cervical effacement and dilation at the first examination recorded on labor and delivery

Parity	Induction	N	Missing, n	Median cervical effacement, %	Mean cervical effacement, %
Nulliparous	Not induced	17,768	1465	90	83.8
	Elective	535	25	75	68.8
	Medically indicated	6,974	672	60	59.8
Multiparous	Not induced	17,959	1465	80	81.6
	Elective	3,240	202	70	64.0
	Medically indicated	4,715	362	60	58.6
					% with cervical dilation ≥3 cm
Nulliparous	Not induced	17,671	1874	4	76.8
	Elective	540	20	3	50.6
	Medically indicated	7,093	553	1	27.9
Multiparous	Not induced	17,532	1892	5	91.3
	Elective	3,293	149	3	67.1
	Medically indicated	4,769	308	2	49.6

Souter et al. Elective induction at term. Am J Obstet Gynecol 2019.