Labor and Labor Arrest Definitions

Normal Labor, Friedman Curves Versus Zhang Curves, Latent Labor, Active Labor, Active Phase Protraction and Arrest Disorder, Second Stage, Induced Labor, Epidural Analgesia

Author, Year	*Setting*	*Design/ approach*	*Subjects*	*Intervention*	*Comparator*	*Sample size*	*Outcomes*	*Quality Assessment*	*Results*
OCC #9 Levels of Maternal Care 2019	United States	Guideline	Women in need of maternal care	Level of maternal care	n/a	Systematic review/ meta-analyses, RCTs, observational studies, literature reviews	Patient care	5.30 out of 7	All facilities should have appropriate equipment for the care and delivery of pregnant women with obesity. All maternity facilities should have the necessary institutional support, including financial, to meet the needs of level-appropriate maternal care.
OCC #1 Safe Prevention of the Primary Cesarean Delivery 2014	United States	Guideline	Pregnant women	Mode of delivery	n/a	Systematic review/ meta-analyses, RCTs, observational studies, literature reviews	Prevention of cesarean delivery, adverse maternal and fetal outcomes	5.30 out of 7	A prolonged latent phase should not be an indication for cesarean delivery. Slow but progressive labor in the first stage of labor should not be an indication for cesarean delivery. Cervical dilation of 6 cm should be considered the threshold for active phase of most women in labor. Cesarean delivery for active phase arrest in the first stage of labor should be reserved for women at or beyond 6 cm of dilation with ruptured membranes who fail to progress despite 4 hours of adequate uterine activity. Before diagnosing arrest of labor in the second stage, if the maternal and fetal conditions permit, allow for the following: at least 2 hours of pushing in multiparous women or at least 3 hours of pushing in nulliparous women.
PB 148 Dystocia and Augmentation of Labor 2004	United States	Guideline	Women with slow, abnormal progression of labor	Interventions for labor dystocia	n/a	Systematic review/ meta-analyses, RCTs, observational	Mode of delivery, adverse maternal and fetal outcomes	5.07 out of 7	Patients should be counseled that walking during labor does not enhance or improve progress in labor nor is it harmful. Continuous support during labor from caregivers should be encouraged because it is beneficial for women and their newborns. Active management of labor may shorten labor in nulliparous women, although it has not consistently been shown

						studies, literature reviews			to reduce the rate of cesarean delivery. Amniotomy may be used to enhance progress in active labor but may increase the risk of maternal fever. X-ray pelvimetry alone as a predictor of dystocia has not been shown to have benefit, and, therefore, is not recommended. Intrauterine pressure catheters may be helpful in the management of dystocia in selected patients, such as those who are obese.
Thierens 2023	Global	Systematic review and meta-analysis	Women in second stage of labour, giving birth by vacuum extraction or cesarean section and registering at least one perinatal or maternal outcome	Vacuum extraction	Second stage C-section	Fifteen articles were included, providing the outcomes for a total of 20 051 births by SSCS and 32 823 births by VE	Maternal and perinatal morbidity	Moderate quality review	Vacuum extraction should be the recommended mode of birth, both in high- income countries and in low- and middle- income countries, to prevent unnecessary SSCS and to reduce perinatal and maternal deaths when safe anesthesia and surgery is not immediately available
Myers 2020 (Labor Dystocia AHRQ report)	Global	Systematic review and meta-analysis	Women aged 15–44 with uncomplicated pregnancy at 37–42 weeks gestation with a singleton pregnancy with vertex presentation	Definitions of abnormalities of the latent and active phases of the first stage of labor (up until complete dilation of the cervix) and of the second stage of labor (from complete dilation until delivery of the infant), developed based on data from the Safe Labor Consortium	Definitions of labor abnormalities based on older data (Friedman Curve)	19 articles	Adverse maternal effects, adverse neonatal effects, labor progress	High quality review	No differences were seen in postpartum hemorrhage rates (moderate SOE), neonatal acidemia rates (low SOE), or vaginal delivery rates (moderate SOE) between women managed with varying partogram strategies. Maternal satisfaction was also no different between partogram strategies (low SOE).Modern labor curves constructed from the Consortium on Safe Labor (CSL) demonstrate significantly different rates of cervical change, duration of labor, and appearance of the curve (absence or presence of an inflection point) between nulliparous and parous women. Modern labor curves constructed from the CSL cohort vary significantly from curves constructed from historical cohorts (Friedman or National Collaborative Perinatal Project [NCPP]), with modern curves suggesting a longer duration of the first stage of labor. Maternal age influences the duration of the first and second stage of labor among nulliparous women (older women having longer labors).
InfanteTorres 2022	Global	Systematic review and meta-analysis	Nulliparous women, a prolonged second stage of labor	-	-	Twelve studies were selected including 266,479 women	5 min Apgar score <7, admission to the Neonatal Intensive Care Unit, neonatal sepsis and neonatal death	Moderate quality review	In nulliparous women, a prolonged second stage of labor is not related with an increased risk of neonatal death. However, it is related with an increased risk of 5 min Apgar score < 7, admission to the Neonatal Intensive Care Unit, neonatal sepsis or intubation. In multiparous women, a prolonged second stage of labor is related with an increased risk of 5 min Apgar score < 7, admission to the Neonatal Intensive Care

									Unit, meconium staining and composite neonatal morbidity.
Saccone 2019	Global	Systematic review and meta-analysis	Asymptomatic women with uncomplicated, singleton gestations at full-term (ie, between 39+0 and 40+6 weeks)	Planned induction of labor	Expectant management	7 RCTs (7,598 participants)	Incidence of cesarean delivery	Moderate quality review	Three studies enrolled only women with favorable cervix, defined as a Bishop score of 5 or greater in nulliparous women or 4 or greater in multiparous women. One trial included only women aged 35 years or older. Women randomized to the planned induction of labor, received scheduled induction usually at 39+0 to 39+6 weeks of gestation, whereas women in the control group received expectant management usually until 41–42 weeks of gestation, or earlier if medically indicated. Methods of induction usually included cervical ripening, with either misoprostol or Foley catheter, in conjunction with or followed by oxytocin for women with unfavorable cervix, and oxytocin and artificial rupture of membranes for those with favorable cervix. Five trials also used artificial rupture of membranes as a method for induction. Uncomplicated full term singleton gestations that were randomized to receive induction of labor had similar incidence of cesarean delivery compared with controls (18.6% vs 21.4%; relative risk 0.96, 95% CI 0.78–1.19). Regarding neonatal outcomes, induction of labor at full-term was associated with a significantly lower rate of meconium-stained amniotic fluid (4.0% vs 13.5%; relative risk 0.32, 95% CI 0.18–0.57), and lower mean birthweight (mean difference −98.96 g, 95% CI −126.29 to −71.63) compared with the control group. There were no between-group differences in other adverse neonatal outcomes.
Abalos 2018	Global	Systematic review	Women with low risk of complications with 'normal' perinatal outcomes	Labor interventions	n/a	37 studies (208,000 women)	Duration of the first stage (total, latent phase, and active phase) and the second stage of labor, definitions	Low quality review	Among nulliparous women, the median duration of active first stage (when the starting reference point was 4 cm) ranged from 3.7–5.9 h (95th percentiles: 14.5–16.7 h). With active phase starting from 5 cm, the median duration was from 3.8–4.3 h (95th percentiles: 11.3–12.7 h). The median duration of second stage ranged from 14 to 66 min (95th percentiles: 65–138 min) and from 6 to 12 min (95th percentiles: 58–76 min) in nulliparous and parous women, respectively. Sensitivity analyses excluding first and second stage interventions did not significantly impact on these findings.

Lavender 2018	Global	Systematic review and meta-analysis	Women in spontaneous labour at term	Partograph	No partograph	11 studies involving 9475 women	Cesarean section, oxytocin augmentation, duration of the first stage of labor, maternal experience of childbirth, Apgar score, serious maternal morbidity or death, stillbirth or neonatal death or neonatal morbidity	High quality review	On the basis of the findings of this review, the authors cannot be certain of the effects of routine use of the partograph as part of standard labour care, or of the different partograph designs.
Gimovsky 2017	Global	Systematic review	Nulliparous women with epidurals and prolonged second stage	Epidural analgesia	n/a	2 studies (5,350 women)	Adverse maternal outcomes, adverse neonatal outcomes	Critically low-quality review	76.3% (4,081/5,350) had an epidural. Of all nulliparous women with an epidural, 11.5% (4,081/35,469) had prolonged second stage. Cesarean delivery occurred in 19.8% of these cases (782/4,081), while 80.2% had a vaginal delivery.
Gupta 2017	Global	Systematic review and meta-analysis	Women in the second stage of labor without epidural anesthesia	Any upright position	Supine position	32 studies (9,015 women)	Duration of second stage of labor, mode of birth, perineal tears, blood loss, admission to NICU	High quality review	In all women studied (primigravid and multigravid), when compared with supine positions, the upright position was associated with a reduction in duration of second stage in the upright group (MD -6.16 minutes, 95% CI -9.74 to -2.59 minutes; 19 trials; 5,811 women; *P*=.0007; random-effects; IO=91%) however, this result should be interpreted with caution due to large differences in size and direction of effect in individual studies. Upright positions were also associated with no clear difference in the rates of caesarean section (RR 1.22, 95% CI 0.81–1.81; 16 trials; 5,439 women), a reduction in assisted deliveries (RR 0.75, 95% CI 0.66–0.86; 21 trials; 6,481 women), a reduction in episiotomies (average RR 0.75, 95% CI 0.61–0.92; 17 trials; 6,148 women; random-effects; IO=88%), a possible increase in second degree perineal tears (RR 1.20, 95% CI 1.00–1.44; 18 trials; 6,715 women; IO=43%), no clear difference in the number of third or fourth degree perineal tears (RR 0.72, 95% CI 0.32–1.65; 6 trials; 1,840 women), increased estimated blood loss greater than 500 mL (RR 1.48, 95% CI 1.10–1.98; 15 trials; 5,615 women; IO=33%), fewer abnormal fetal heart rate patterns (RR 0.46, 95% CI 0.22–0.93; 2 trials; 617 women), no clear difference in the number of babies admitted to neonatal intensive care (RR 0.79, 95% CI 0.51–1.21; 4 trials; 2,565 infants). On sensitivity analysis excluding trials with high risk of bias, these findings were unchanged except that there was no longer a clear difference in duration of second stage of labor (MD -4.34, 95% CI -9.00 to 0.32; 21 trials; 2,499 women; IO=85%).
Kibuka 2017	Global	Systematic review and meta-analysis	Women with epidural anesthesia in the	Upright position	Recumbent position	5 RCTs (879 women)	Operative birth, duration of second stage labor, trauma to birth	High quality review	Overall, we identified no clear difference between upright and recumbent positions on our primary outcomes of operative birth (caesarean or instrumental vaginal) (average risk ratio (RR) 0.97; 95% CI 0.76–

			second stage of labor				canal requiring suturing, blood loss, abnormal fetal heart rate patterns requiring intervention, low cord pH, admission to NICU		1.29; five trials, 874 women; I^2=54%), or duration of the second stage of labor measured as the randomization-to-birth interval (average mean difference –22.98 minutes; 95% CI -99.09 to 53.13; two trials, 322 women; I^2=92%). Nor did we identify any clear differences in any other important maternal or fetal outcome, including trauma to the birth canal requiring suturing (average RR 0.95; 95% CI 0.66–1.37; two trials; 173 women; two studies; I^2=74%), abnormal fetal heart patterns requiring intervention (RR 1.69; 95% CI 0.32–8.84; one trial; 107 women), low cord pH (RR 0.61; 95% CI 0.18–2.10; one trial; 66 infants) or admission to neonatal intensive care unit (RR 0.54; 95% CI 0.02–12.73; one trial; 66 infants). However, the CIs around each estimate were wide, and clinically important effects have not been ruled out. Outcomes were downgraded for study design, high heterogeneity and imprecision in effect estimates. There were no data reported on blood loss (greater than 500 mL), prolonged second stage or maternal experience and satisfaction with labor. Similarly, there were no analyzable data on Apgar scores, and no data reported on the need for ventilation or for perinatal death.
Hanley 2016	Global	Systematic review	Laboring women	Labor onset (latent phase, active phase, first stage and unspecified)	n/a	62 studies	Definitions	Critically low quality review	Labor onset was most commonly defined through the presence of regular painful contractions (71% of studies) and/or some measure of cervical dilatation (68% of studies). However, there was considerable discrepancy about what constituted onset of labor even within 'type' of labor onset. The majority of studies did not provide evidentiary support for their choice of definition of labor onset.
Brancato 2008	Global	Systematic review and meta-analysis	Women with effective epidural analgesia	Immediate pushing	Delayed pushing	7 studies (2,827 women)	Instrument-assisted deliveries, noninstrumental or spontaneous vaginal births, cesarean births, pushing time, episiotomies, lacerations, maternal fatigue, fetal well-being	Low quality review	Pooled data indicate that passive descent increases a woman's chance of having a spontaneous vaginal birth (relative risk: 1.08; 95% CI 1.01–1.15; *P*=.025), decreases risk of having an instrument-assisted delivery (relative risk: 0.77; 95% CI 0.77–0.85; *P*≤.0001), and decreases pushing time (mean difference: -0.19 hours; 95% CI -0.27 to -0.12; *P*≤.0001). No differences were found in rates of cesarean births (relative risk: 0.80; 95% CI 0.57–1.12; *P*=.19), lacerations (relative risk: 0.88; 95% CI 0.72–1.07; *P*=.20), or episiotomies (relative risk: 0.97; 95% CI 0.88–1.06; *P*=0.45).
Roberts 2005	Global	Systematic review and meta-analysis	Women with uncomplicated pregnancies at term with epidural analgesia established in the first stage of labor	Upright	Recumbent	2 studies (281 women)	Instrumental delivery, cesarean section, length of the second stage, fetal malposition, perineal trauma, postpartum hemorrhage, adequacy of pain relief, satisfaction with care, and	Moderate quality review	Upright positions in the second stage were associated with a non-significant reduction in the risk of both instrumental delivery (relative risk (RR)=.77, 95% CI 0.46–1.28) and cesarean section (RR=0.57, 95% CI 0.28–1.16). Both studies reported a statistically significant reduction in labor duration associated with upright positions. Data on other outcomes, including perineal trauma, postpartum hemorrhage, maternal satisfaction, and infant well-being, were insufficient.

							longer-term outcomes, neonatal outcomes		
Roberts 2004	Global	Systematic review and meta-analysis	Laboring women who had effective epidural analgesia in the first stage	Delayed pushing	Early pushing	9 trials (2,929 women)	Instrumental delivery, rotational or mid-pelvic instrumental deliveries, second stage caesarean section, length of second stage, duration of pushing, episiotomy, perineal laceration, postpartum hemorrhage, maternal fever, satisfaction with labor care, longer term outcomes, neonatal outcomes	Moderate quality review	There was a non-significant reduction in instrumental deliveries in six of the nine studies. Meta-analysis showed an overall small reduction which failed to reach statistical significance. However, meta-analysis of the results from studies which measured the rates of rotational or mid-pelvic instrumental deliveries showed a 31% reduction which was statistically significant. There was also a non-significant reduction in the rates of second stage caesarean section. The duration of second stage was significantly longer among women allocated to the delayed pushing group in eight studies individually, but the impact on duration of pushing varied. Using a random effects model, there was a statistically significant increase in the duration of second stage of labor (58 minutes) but no difference in the duration of pushing associated with delayed pushing. There were no other statistically significant maternal morbidity results, with similar rates among delayed and early pushing groups for episiotomy, perineal lacerations, postpartum hemorrhage and maternal satisfaction with labor care. Subgroup analyses were limited to the primary outcome, instrumental deliveries. The only statistically significant reduction in instrumental deliveries was in the prespecified subgroup of studies where the epidurals contained local anesthetic (bupivacaine) alone. In the post hoc analyses, the relative risk of instrumental delivery associated with delayed pushing was lower in the subgroup with high forceps rates, but this finding was not significantly different to either the overall result or the low forceps rate subgroup.
Leighton 2002	Global	Systematic review and meta-analysis	Parturient women	Epidural analgesia	Other method of pain relief	14 RCTs (4,324 women)	Incidence of cesarean delivery, pain relief, instrumental vaginal delivery, labor length, oxytocin, hypotension, fever, nausea, pain, satisfaction, back pain, fetal heart rate abnormalities, Apgar score, umbilical cord artery pH, asphyxia, need for naloxone	Moderate quality review	The incidence of cesarean delivery for any indication did not differ between patients randomized to receive parenteral opioids (7.7% [167/2,163]) and patients randomized to receive epidural analgesia (8.0% [172/2,161]) for labor pain relief (OR, 1.00; 95% CI 0.77–1.28). All of the studies except one4 give similar results. We could not detect heterogeneity in the study results for this outcome ($\chi 2$; P=.34). Similarly, there was no difference in the incidence of cesarean delivery for any indication if only high-quality studies (Jadad score=3) were considered (parenteral opioid group, 8.9% [104/1,164] vs epidural group, 9.0% [104/1,156]; OR, 1.02; 95% CI 0.67–1.55; P=ns). The incidence of poor 1-minute Apgar scores and the need for neonatal naloxone were higher in the parenteral opioid group. The incidences of fetal heart rate abnormalities/intrapartum meconium, poor 5-minute Apgar scores, and low umbilical artery pH did not

									differ between the groups. We could not detect heterogeneity in these study results.
Wood, 2023	Canada	Randomized control trial	Nulliparous women with a singleton vertex-presenting fetus at term (>37 weeks' gestation).	Multimodal knowledge translation program of the new dystocia guidelines	No program implementation	26 Canadian hospitals (13 control sites, 13 intervention sites)	Cesarian delivery rates	Moderate risk of bias	Cesarean delivery rates in nulliparous women were not reduced by the application of recent guidelines for the diagnosis of nonprogressive labor. Spontaneous vaginal delivery—a secondary outcome—was increased in the intervention group. The intervention appears to be safe.
Bernitz 2019	Norway	Randomized controlled trial	Nulliparous women who had a singleton, full-term fetus with cephalic presentation, and who entered spontaneous active labour	Zhang's guideline	WHO partograph	7,277 women	Use of intrapartum caesarean section (ICS) during active labour (cervical dilatation of 4–10 cm)	High risk of bias	Of these women, 3,305 (45.4%) participants were in an obstetric unit that was randomly assigned to the control group (adhering to the WHO partograph) and 3,972 (54.6%) participants were in an obstetric unit that was randomly assigned to the intervention group (adhering to Zhang's guideline). No women dropped out during the trial. Before the start of the trial, ICS was used in 9.5% of deliveries in the control group obstetric units and in 9.3% of intervention group obstetric units. During our trial, there were 196 (5.9%) ICS deliveries in women in the control group (WHO partograph) and 271 (6.8%) ICS deliveries in women in the intervention group (Zhang's guideline), and the frequency of ICS use did not differ between the groups (adjusted relative risk 1.17, 95% CI 0.98–1.40; *P*=.08; adjusted risk difference 1.00%, 95% CI -0.1 to 2.1). We identified no maternal or neonatal deaths during our study.
Grobman 2018	United States	Randomized controlled trial	Low-risk nulliparous women	Labor induction	Expectant management	3,062 women	Composite of perinatal death or severe neonatal complications, cesarean delivery	High risk of bias	The primary outcome occurred in 4.3% of neonates in the induction group and in 5.4% in the expectant-management group (relative risk, 0.80; 95% CI 0.64–1.00). The frequency of cesarean delivery was significantly lower in the induction group than in the expectant-management group (18.6% vs. 22.2%; relative risk, 0.84; 95% CI 0.76–0.93).
The Epidural and Position Trial Collaborative Group 2017	United Kingdom	Randomized controlled trial	Nulliparous women aged 16 or older, at term with a singleton cephalic presentation and in the second stage of labor with epidural analgesia	Upright position	Lying down position	3,093 women	Spontaneous vaginal birth, mode of birth, perineal trauma, infant Apgar score, admission to a neonatal unit, longer term included maternal physical and psychological health, incontinence, infant gross developmental delay	Low risk of bias	Significantly fewer spontaneous vaginal births occurred in women in the upright group: 35.2% (548/1,556) compared with 41.1% (632/1,537) in the lying down group (adjusted risk ratio 0.86, 95% CI 0.78–0.94). This represents a 5.9% absolute increase in the chance of spontaneous vaginal birth in the lying down group (number needed to treat 17, 95% CI 11–40). No evidence of differences was found for most of the secondary maternal, neonatal, or longer term outcomes including instrumental vaginal delivery (adjusted risk ratio 1.08, 99% CI 0.99–1.18), obstetric anal sphincter injury (1.27, 0.88–1.84), infant Apgar score less than 4 at five minutes (0.66, 0.06–6.88), and maternal fecal incontinence at one year (1.18, 0.61–2.28).

Gimovsky 2016	United States	Randomized controlled trial	Nulliparous women with singleton gestations at 36 0/7 to 41 6/7 weeks gestation who reached prolonged second stage of labor	Extended labor for at least 1 additional hour	Usual labor	78 women	Incidence of cesarean delivery, maternal and neonatal outcomes	High risk of bias	All of the women had epidural anesthesia. Maternal demographics were not significantly different. The incidence of cesarean delivery was 19.5% (n=8/41 deliveries) in the extended labor group and 43.2% (n =16/37 deliveries) in the usual labor group (relative risk, 0.45; 95% CI 0.22–0.93). The number needed-to-treat to prevent 1 cesarean delivery was 4.2. There were no statistically significant differences in maternal or neonatal morbidity outcomes.
Genc 2015	Turkey	Randomized controlled trial	Nulliparous at-term pregnant women during vaginal delivery	Epidural analgesia	No epidural analgesia	100 women	Nausea, vomiting, sedation, tremor, vacuum-assisted and instrumental delivery	Unclear/low risk of bias	The duration of the first stage of labor was significantly shortened, while the second stage was significantly lengthened in pregnant women who underwent epidural analgesia (*P*<.05).
Ohel 2006	Israel	Randomized controlled trial	Term nulliparous women in early labor, at less than 3 cm of cervical dilatation	Immediate initiation of epidural analgesia at first request	Delay of epidural until the cervix dilated to at least 4 cm	449 women	Incidence of cesarean delivery, incidence of operative vaginal deliveries, duration of labor, use of systemic analgesia and of oxytocin, incidence of meconium and fever, neonatal outcome, degree of maternal control, maternal satisfaction with the epidural analgesia	Low risk of bias	At initiation of the epidural the mean cervical dilatation was 2.4 cm in the early epidural group and 4.6 cm in the late group (*P*<.0001). The rates of cesarean section were not significantly different between the groups –13% and 11% in the early and late groups, respectively (*P*=.77). The mean duration from randomization to full dilatation was significantly shorter in the early compared to the late epidural group –5.9 hours and 6.6 hours respectively (*P*=.04). When questioned after delivery regarding their next labor, the women indicated a preference for early epidural.
Windrim 2007	Canada	Randomized controlled trial	Primiparous women with uncomplicated pregnancies at term	Partogram group	Standard group	1,932 women	Rate of cesarean section, rates of obstetric intervention for dystocia	High risk of bias	There was no significant difference between the groups in rates of cesarean section (partogram 24%, standard notes 25%), rates of other interventions, amniotomy, oxytocin use, or the mean cervical dilatation in labor.
Ragnar 2006	Sweden	Randomized controlled trial	Primiparous subjects	Kneeling position during second stage of labor	Sitting position during second stage of labor	271 subjects	Duration of the second stage of labour	High risk of bias	A comparison of the duration of the second stage of labour (kneeling 48.5 minutes ± 27.6 SD, sitting 41 minutes ± 23.4 SD) revealed no significant difference between the groups. A sitting position during the second stage of labour was associated with a higher level of delivery pain (*P*<.01), a more frequent perception of the second stage as being long (*P*=.002), less comfort for giving birth (*P*=.03) and more frequent feelings of vulnerability (*P*=.05) and exposure (*P*=.02). There were no significant differences in the frequency of sphincter ruptures although a sitting position was associated with a higher degree of postpartum perineal pain (*P*<.001).

Salim 2005	Israel	Randomized controlled trial	Nulliparous women who requested epidural analgesia during labor	Continuous infusion of 0.125% bupivacaine with 2 g/mL fentanyl at a rate of 8 mL/h (Group A)	Intermittent bolus of 10 mL of 0.25% bupivacaine on demand (Group B), controls were nulliparous women who did not receive epidural analgesia (group C)	190 parturients	Mean durations of the active phase of labor and the second stage of labor, maternal and neonatal outcome	High risk of bias	Mean duration of the active phase and the second stage of labor were not statistically different between groups A and B. Each technique produced comparable analgesia, achieving equivalent maternal satisfaction, with no apparent complications. The active phase of labor was prolonged by an average of 60 minutes and the 2nd stage by an average of 36 minutes regardless of the type of epidural compared with controls. The mode of delivery and maternal and neonatal outcome were not significantly different among the 3 groups.
Plunkett 2003	United States	Randomized controlled trial	Nulliparas with standardized patient-controlled epidural analgesia	Pushing immediately	Waiting for strong urge to push	202 women	Duration of pushing, total duration	High risk of bias	Women who delayed pushing and those who pushed immediately were similar with respect to maternal characteristics. Women who delayed pushing had a stronger urge to push (*P*<.01) and a longer second stage (*P*<.05) than women who pushed immediately. There was no significant difference in the time spent pushing (median 57 versus 62 minutes, respectively) or the median level of patient satisfaction (80 mm for both groups). There were no significant differences in the overall rates of cesarean delivery (6% versus 12%, respectively), cesarean delivery during the second stage (2% in each group), spontaneous vaginal delivery (70% versus 69%, respectively), or neonatal or maternal morbidity.
Downe 2004	United Kingdom	Randomized controlled trial	Nulliparous women using epidural analgesia and reaching the second stage of labour with no contraindications to spontaneous birth	Lateral sitting position during the passive second stage of labour	Supported sitting position during the passive second stage of labour	107 women	Mode of birth, incidence of episiotomy, perineal suturing	High risk of bias	Lateral position was associated with lower rates of instrumental birth rate (lateral group 33%; sitting group 52%; *P*=.05, RR 0.64, CI for RR: 0.40–1.01; Number-needed-to-treat (NNT)=5), of episiotomy (45% vs. 64%; *P*=.05, RR 0.66, CI for RR: 0.44–1.00, NNT=5), and of perineal suturing (78% vs. 86%; *P*=.243, RR 0.75, CI for RR 0.47–1.17). The odds ratio for instrumental birth in the sitting group was 2.2 (CI 1.00–4.6). Logistic regression of potential confounder variables was undertaken, due to a large variation in maternal weight between the randomised groups. Of the nine possible confounders tested, only position of the baby's head at full dilation affected the risk of instrumental birth significantly (*P*=0.4, OR 2.7 where the fetal head was in the lateral or posterior position). Maternal weight did not appear to have any effect. The odds ratio for instrumental delivery for women randomised to the sitting position was slightly higher within the logistic regression model (adjusted OR 2.3).
Fitzpatrick 2002	Ireland	Randomized controlled trial	Nulliparous women at full dilatation	Immediate pushing	Delayed pushing	170 women	Mode of delivery, altered fecal continence	Unclear/low risk of bias	The spontaneous delivery rate was 56% (50/90) in the immediate pushing group and 52% (46/88) in the delayed pushing group. Mean duration of labor for the immediate pushing group was 427 minutes compared with 480 minutes for the delayed pushing group

									(*P*=.005). Eighty-four percent (76/90) of women in the immediate pushing group received oxytocin to augment labour, 21/76 (28%) in the second stage only. Eighty-one percent (71/88) of women in the delayed pushing group received oxytocin to augment labor, 22/71 (31%) in the second stage only. Fetal outcome did not differ between the two groups. Episiotomy rates were 73% and 69% in the immediate pushing and delayed pushing groups, respectively. 26% (23/90) of the immediate pushing group and 38% (33/88) of the delayed pushing group complained of altered fecal continence after delivery (NS). Manometry, ultrasound and neurophysiology studies did not differ significantly between the two groups. Overall, 55% of women after instrumental delivery had endosonographic evidence of damage to the external anal sphincter, while 36% of women after spontaneous delivery had abnormal neurophysiology studies.
Sadler 2000	New Zealand	Randomized controlled trial and meta-analysis	Nulliparous women in spontaneous labor at term with singleton pregnancy and cephalic presentation and without fetal distress	Active management	Routine care	651 women	Rates of cesarean section, operative vaginal delivery, prolonged labor, febrile complications, postpartum hemorrhage, satisfaction with labor care, NICU admission, depression at birth, acidosis	High risk of bias	Active management of labor did not reduce the rate of cesarean section 30/320 (9.4%), compared with 32/331 (9.7%) for routine care, but did shorten the length of first stage of labor (median 240 min vs 290 min; *P*=0.02), and reduce the relative risk of prolonged labor (RR 0.39; 95% CI 0.22–0.71). There were no differences between groups in the rates of newborn nursery admission, neonatal acidosis, low Apgar scores, or postpartum haemorrhage. Satisfaction with labour care was high (77%) and did not differ between groups.
Rouse 1999	United States	Randomized control trial	Pregnant women with cervix at least 4 cm dilated and 1 cm or less of cervical progress in 2 hours	Oxytocin augmentation for 4 hours	Oxytocin augmentation for 2 hours	542 women	Vaginal birth	Moderate risk of bias	The subsequent vaginal delivery rate for parous women who had not progressed (1 cm of cervical dilation or less) despite 2 hours of oxytocin augmentation was 91%, and it was 74% for nulliparas. With no labor progress after 4 hours of oxytocin augmentation, the subsequent vaginal delivery rates were 88% for parous women and 56% for nulliparas. There were no severe maternal complications.
Arulkumaran 1987	Singapore	Randomized control trial	Pregnant women in labor	Labor augmentation	-	2,803 women	Mode of delivery	Moderate risk of bias	Multiparas responded better to oxytocin augmentation; 86.7% of the patients with PDL and 55.6010 of the patients with SAL had satisfactory labour progress after augmentation
Blankenship 2020	United States	Retrospective analysis	Women admitted for delivery at ≥37 weeks and 0 to 7 days of gestation with singleton, nonanomalous, vertex infants	Above and below the 90th, 95th, and 97th percentiles for first stage of labor duration	Between groups	6,823 women	Maternal morbidity, neonatal morbidity	Serious risk of bias	682 were anticipated to have first stage of labor duration above the 90th percentile cutoff point, which was associated with an increased risk of composite maternal morbidity, maternal fever, postpartum transfusion, prolonged second stage of labor duration, third- or fourth-degree perineal laceration, and cesarean or operative vaginal delivery (*P*≤.02) and an increased risk of composite neonatal morbidity, respiratory distress syndrome, need for mechanical ventilation, and

									neonatal sepsis (*P*≤.03). Composite maternal morbidity was 2.2 (95% CI 1.8–2.7), 1.9 (95% CI 1.4–2.4), and 1.8 (95% CI 1.3–2.5) times more likely to occur among women above the 90th, 95th, and 97th percentile, respectively, for first stage of labor duration from 4 to 10 cm. Composite neonatal morbidity was 2.6 (95% CI 2.1–3.2), 2.2 (95% CI 1.7–2.9), and 1.9 (95% CI 1.3–2.8) times more likely to occur among infants delivered by women above the 90th, 95th, and 97th percentiles for first stage of labor duration from 4 to 10 cm. Receiver operating characteristic curves among all women from 4 to 10 cm and 6 to 10 cm, including when stratified by parity and type of labor onset, had an area under the curve of 0.51 to 0.62 and 0.53 to 0.71 for maternal and neonatal morbidity, respectively. Thus, duration of labor has moderate predictive ability, at best, for composite maternal or neonatal morbidity. No curve demonstrated a clear point at which adverse maternal or neonatal outcomes increased that could be used to define abnormal labor.
Shumeli 2018	Israel	Retrospective cohort analysis	Live, singleton, term (37–42 weeks) vaginal deliveries	Labor intervention(s)	n/a	15,500 deliveries	Duration of second stage of labor	Serious risk of bias	Nulliparity, oxytocin augmentation, epidural use, birthweight, labor induction, lower body mass index, and higher maternal age were found to be significantly associated with prolongation of the second stage. Epidural use was associated with an additional 82 minutes for the 95th percentile for both nulliparas and multiparas and tripled the rate of prolonged second stage for the entire cohort. Labor induction was associated with clinically significant prolongation of the second stage in nulliparas with epidural analgesia only. Oxytocin was associated with longer duration of the second stage for nulliparas, regardless of epidural use.
Schiessel 2015	Germany	Analysis	Women with gestational age of at least 35 + 0 weeks, singleton pregnancies, and cephalic presentation, vaginal deliveries	Vaginal examinations at multiple time points	n/a	1,200 deliveries	Parity, duration of first and second stage of labor, maternal age, birth weight, position of the fetal head, epidural analgesia, oxytocin augmentation	Moderate risk of bias	The mean length of the second stage was 70 min. In univariate analysis, parity, oxytocin augmentation and epidural analgesia, as well as occiput posterior presentation were significant parameters associated with a prolonged second stage of labor. No correlation was found for birth weight and maternal age. In multivariate regression analysis, nulliparity and epidural analgesia were the strongest risk factors for a prolonged second stage.
Favilli 2020	Italy	Retrospective review	Women with singleton, at term deliveries, laboring with EA	Women aged 35 years or older	Women aged less than 35 years	459 women	EA effects on duration of labor and neonatal outcome	Moderate risk of bias	The multiple regression analysis showed that parity was an independent variable for a shorter dilation period (*P*=.002), second stage length (*P*=.0001) and for the total labor duration (*P*=.0001); neonatal weight was significant for a shorter dilation period (*P*=.005) and for the total labor duration (*P*=.002); maternal age and cervical dilatation at the beginning of EA did not influence neither the period of the labor stages nor the total labor duration (*P*>.05).

Gimovsky 2021	United States	Retrospective cohort	Nulliparous women with singleton gestations and cephalic presentation who reached 10 cm of cervical dilation at gestational age 36	Epidural	No epidural	Six hundred sixty-one women were evaluated	Incidence of vaginal delivery	Moderate risk of bias	In nulliparous women at term with singleton gestations who reached second stage, the chance of vaginal delivery was 92.7%; even after 5 h of second stage, most women delivered via vaginal delivery (70.4%, 81/115). In those with epidural anesthesia, the PSS group had similar perinatal outcomes as the NSS group, whereas the EPSS group had significantly worse perinatal outcomes. Second stage 5 h is a potential tipping point for hazardous perinatal outcomes.
Blankenship 2019	United States	Retrospective cohort	Patients with a term vertex singleton who achieved 10-cm cervical dilation	Labor curves for patients who delivered large-for-gestational age infants (actual birthweight, >90th percentile for gestational age)	Labor curves for patients who delivered appropriate-for-gestational age infants (actual birthweight, 10-90th percentile for gestational age)	17,097 women	Median time of cervical dilation from 3-10 cm by 1-cm increments (eg, 3-4 cm), stratified by infant birthweight	Moderate risk of bias	15,843 women (92.7%) had appropriate-for-gestational age infants; 1,254 women (7.3%) had large-for-gestational age infants, of whom 387 (30.9%) were nulliparous; 464 women (37.0%) underwent induction of labor; 863 women (68.8%) were obese, and 158 women (12.6%) had diabetes mellitus or gestational diabetes mellitus. Women with large-for-gestational age infants had a slower progression from 3- to 10-cm cervical dilation compared with those with appropriate-for-gestational age infants (median, 8.57 hours [5th, 95th percentile 2.95–24.86] vs 6.46 hours [5th, 95th percentile 2.23–18.74]; *P*<.01). In the large-for-gestational age group, dilation from 6e10 cm progressed slower in nulliparous compared with multiparous women (3.28 hours [5th, 95th percentile 0.71–15.16] vs 2.03 hours [5th, 95th percentile 0.44–9.39]; P<.01) and in obese compared with not obese women (2.36 hours [5th, 95th percentile 0.51–10.91] vs 1.79 hours [5th, 95th percentile 0.39–8.31]; P<.01). Labor curves did not differ between large-for-gestational age and appropriate for gestational age groups when stratified by labor onset (nonaugmented spontaneous labor vs induced labor) or the presence of diabetes mellitus or gestational diabetes mellitus.
Cheng 2014	United States	Retrospective cohort	Cephalic, live, singleton births	Epidural use	No epidural use	42,268 women	Median and the 95th percentile lengths of second stage of labor, length of second stage of labor based on neonatal outcomes	Moderate risk of bias	Compared with women without epidural use, the 95th percentile length of second stage for nulliparous women was 197 minutes without epidural and 336 minutes with epidural (*P*<.001), a difference of 2 hours and 19 minutes. For multiparous women, the 95th percentile length of second stage was 81 minutes without epidural and 255 minutes with epidural (*P*<.001), a difference of 2 hours and 54 minutes.
Loewenberg-Weisband 2014	Israel	Historical cohort	Women with term delivery and an uncomplicated singleton pregnancy, cephalic presentation	Epidural analgesia during delivery	No epidural analgesia	61,308 women	Severe (third and fourth degree) perineal tears	Moderate risk of bias	SPT occurred in 0.3% of births. Deliveries with epidural had significantly higher rates of primiparity, induction and augmentation of labor, prolonged second stage of labor, instrumental births and midline episiotomies. The univariate analysis showed a significant association between the use of epidural and SPT (OR: 1.78, 95% CI 1.34–2.36); however, this association disappeared when parity was introduced (OR:

			and vaginal delivery						0.95, 95% CI 0.69–1.29). Instrumental deliveries and prolonged second stage of labor were both strongly associated with SPT (ORs of 1.82 and 1.77).
Tilden 2023	Netherlands	Population cohort	Parous women without a history of cesarean delivery in spontaneous labor with a term (≥37 weeks of gestation), singleton, live, and vertex fetus without major malformations	Duration of the latent phase of labor and perinatal processes	-	67,267 pregnancies with deliveries	Maternal/fetal outcomes	Low risk of bias	The duration of the latent phase of labor in nulliparous women was longer than that of multiparous women at each point of distribution. A longer duration of the latent phase of labor was associated with more frequent dystocia diagnoses and related interventions during the first stage active phase or second stage of labor, including cesarean delivery, nulliparous fetal occiput posterior position, chorioamnionitis, and markers of neonatal morbidity.
Munro 2018	Canada	Population-based retrospective cohort analysis	Nulliparous women at term gestation (37 weeks or later), laboring with a singleton pregnancy in vertex presentation, and received epidural analgesia	Epidural top-up during second stage	No epidural top-up during second stage	1,462 women	Length of the second stage, method of delivery, augmentation/induction use and neonatal characteristics	Serious risk of bias	Of the 1,462 women with a second stage of labor one hour who received epidural analgesia, 105 (7%) required a top-up during the second stage of labor. Women who received a top-up were more likely to have had induction of labor and/or augmentation (89% vs 76%; odds ratio [OR], 2.43; 95% CI 1.32–4.49; *P*=.003), a longer second stage (303 min vs 171 min; mean difference, 132 min; 95% CI 113–151; *P*<.001), and more assisted vaginal (41% vs 17%; OR, 3.35; 95% CI 2.21–5.1; *P*<.001) or cesarean deliveries (26% vs 11%; OR, 3.04; 95% CI 1.91–4.8; *P*<.001) than women without a top-up.
Chaemsaithong 2019	Hong Kong	Prospective longitudinal study	Pregnant women with a live fetus in cephalic presentation and intact membranes who underwent induction of labor between 37$\underline{+}$0 and 42$\underline{+}$6 weeks gestation for various indications and subsequently delivered vaginally	Method used for induction of labor	Different methods for induction of labor	315 women	Labor progress, maternal characteristics	Low risk of bias	The total number of paired vaginal examination and transperineal ultrasonographic assessments among the 261 women (82.9%) with vaginal delivery was 945, with a median of 3 per woman. The median assessment-to-assessment interval was 4.6 hours (interquartile range, 4.3–5.2). Multiparity and mechanical methods of labor induction were associated with a faster rate of fetal head descent, which was determined by head perineum distance against fetal head station, than nulliparity and the use of a slow-release vaginal pessary, respectively. An additional increase of 0.10 cm in head-perineum distance was observed, for an unit increase in fetal head station in nulliparous women (*P*=.03) and women who had a slow-release vaginal pessary (*P*=.02), compared with multiparous women and those who had mechanical methods for labor induction. The use of epidural anesthesia was associated with a slower rate of fetal head descent, which was determined by both parasagittal angle of progression and head perineum distance, against fetal head station. An additional decrease of 3.66 degrees in parasagittal angle of progression (*P*=.04) and an additional increase in 0.33 cm in head-

									perineum distance ($P \leq .001$) were observed for a unit increase in fetal head station in women with the use of epidural anesthesia, compared with those without. Obese women had higher head perineum distance overall, compared with normal weight women; at different cross-sections of time periods, obesity appeared to be associated with a slower rate of change between head-perineum distance and cervical dilation. Advanced maternal age did not affect transperineal ultrasound determined labor progress ($P > .05$).
Indraccolo 2012	Italy	Prospective observational	Low-risk women with epidural analgesia	Epidural analgesia	Compared between doses	499 women	Speed of dilatation (SD) (centimeters of dilatation / hours), speed of lowering of the fetal head through maternal pelvis (SL) (centimeters in lowering / hours), time of active phase of labor (TA), cesarean section (CS), vacuum application (VA)	Serious risk of bias	Dilution of ropivacain, fentanyl amount, and volume of the first dose of epidural analgesia did not seem to affect labor times. Epidural analgesia with schemes used in this study favored both the dilatation and the fetal head lowering through maternal pelvis. Every five minutes from the first dose of epidural to the last top-up, SD decreased by about 13% ($P=.002$), SL decreased by about 14% ($P<.001$), and TA increased by about 40% ($P<.001$). Additionally, every five minutes from the first dose of epidural to the last top-up, the odds of an operative vaginal birth (vacuum) increased by 0.7% ($P<.001$). Increasing of number of top-ups independently caused a reduction in odds of undergoing CS (odds ratio 0.434; 95% CI 0.219–0.859, $P=.017$), without influencing labor times.
Poignant 2012	Sweden	Population based register study	Primiparous women giving birth in gestational week 37+0 to 41+6	Induction of labor and epidural analgesia	n/a	415,230 women	Indication for operative delivery as well as vacuum extraction (VE) and emergency c-section (EMCS)	Serious risk of bias	Among the VE deliveries the indication ‘‘signs of fetal distress’’ increased while ‘‘multiple indications’’ decreased. For EMCS, ‘‘prolonged labor’’ increased steadily while ‘‘multiple indications’’ decreased. The total rate of induction of labor increased from 8.2% in 1999 to 11.9% in 2010 and was associated with an increased risk of both EMCS (OR 3.37) and VE (OR 1.5). The total rate of EA increased from 43.7% in 1999 to 49.8% in 2010 and was associated with a double risk for VE (OR=2.23) and with an increased risk of EMCS (OR=1.64).
Frigo 2011	Italy	Perspective cohort	Nulliparous parturients	Epidural	Combined spinal epidural (CSE) analgesia	600 parturients	Cervical dilatation rate, second stage durations	Moderate risk of bias	The mean duration of the first stage was 4 h and 30 min (SD 1.52 h) and the mean duration of the second stage was 1 h and 10 min (SD 0.43). In the second stage, the CSE analgesia labors showed an overall faster progression compared to the epidural labors but both lasted longer than the duration reported by Zhang (53 min) and Friedman (39 min). Both the first and the second-stage duration were significantly lower if neuraxial analgesia was performed as a CSE procedure with respect to the simple epidural procedure (first stage 4 h and 1 min vs 4 h and 60 min, $P=.043$; second stage 1 h and 5 min vs 1 h and 15 min, $P=.0356$).

Gerli 2011	Italy	Retrospective case-control	Singletons, normal pregnancies, with vertex presentation, at or beyond 36 weeks' gestation	Analgesia	No analgesia	1,510 women	Duration of labor	Moderate risk of bias	The duration of the first stage, second stage, and total duration of labor was longer in epidural group, however epidural analgesia was not demonstrated as an independent risk factor for a prolonged labor. The variable most influencing the total duration of labor and the duration of the first stage was nulliparity; the variables most influencing the duration of the second stage were the older age, a reduced body mass index, a high newborn weight and nulliparity.
Nguyen 2010	United States	Prospective cohort	Nulliparous women and multiparous women without a previous cesarean delivery	Epidural analgesia	No epidural analgesia	2,052 women	Route of delivery: operative vaginal delivery or cesarean section delivery	Moderate risk of bias	After adjusting for differences between women who used and those who did not use epidural analgesia in 1st stage of labor, epidural use was associated with a 2.5 relative risk (95% CI 1.8–3.4) for operative vaginal delivery in nulliparous women, and a 5.9 relative risk (95% CI 3.2–11.1) in multiparous women. Epidural use was associated with a 2.4 relative risk (95% CI 1.5–3.7) for cesarean delivery in nulliparous women, and a 1.8 relative risk (95% CI 0.6–5.3) in multiparous women.
O'Hana 2007	Israel	Population-based study	Nulliparous women	Epidural analgesia	No epidural analgesia	39,498 deliveries	Vacuum extraction, cesarean section, labor dystocia, labor induction, failed labor induction, Apgar score, fetal distress, congenital malformations, perinatal mortality, birth weight	Moderate risk of bias	Using a multivariable analysis with backward elimination, the following conditions were significantly associated with the use of epidural analgesia: advanced maternal age, oligohydramnios, premature rupture of membranes, induction of labor, and Jewish (vs. Bedouin) ethnicity. These patients were more likely to deliver by cesarean delivery (CD; OR=1.4, 95% CI 1.3–1.5; *P*<.001) and vacuum extraction (OR=1.5, 95% CI 1.4–1.7; *P*<.001). After controlling for possible confounders such as macrosomia, failed induction, hypertensive disorders, gestational diabetes, maternal age, labor dystocia, and ethnicity, epidural analgesia was not found to be an independent risk factor for CD but rather a protective factor (OR=0.9, 95% CI 0.8–0.9; *P*=.038). When vacuum extraction was the outcome variable, epidural analgesia was documented as an independent risk factor (OR=1.1, 95% CI 1.01–1.3; *P*=.04).
de la Chapelle 2006	France	Case-control	All nulliparous Caucasian women at low obstetric risk in spontaneous labour	Walking epidural analgesia using 0.0625% bupivacaine	Epidural analgesia using 0.125% or 0.25% bupivacaine while recumbent	220 women	Type of delivery, time between insertion of the epidural catheter and delivery, duration of the first and second stages of labour, occipital presentation at delivery, type and number of FHR decelerations, number of episiotomies, total	Moderate risk of bias	Maternal and obstetric parameters, fetal status and presentation, and oxytocin use were comparable among groups. Those receiving walking epidural analgesia walked for a mean of 60 min (range: 20–75 min). In the control groups the mean total durations of labour were shorter (58 min in the 0.125% group and 99 min in the 0.25% group, *P*<.05). Significantly fewer walking epidural analgesia cases than controls required instrumental vaginal delivery (*P*<.05). No other differences in obstetric or fetal outcome were observed and no mother fell or stumbled while walking.

							amount of oxytocin administered		
Bodner-Adler 2003	Austria	Retrospective multicenter and analysis	All women with uncomplicated pregnancy, a gestational age >37 weeks and a pregnancy with cephalic presentation	Epidural analgesia	No epidural analgesia	1,009 women	Occurrence of an obstetric laceration, duration of second stage of labour, occurrence of obstetric lacerations, presence or absence of episiotomy, use of oxytocin to augment labour, Apgar score, cord pH	Moderate risk of bias	Epidural analgesia showed no influence on the rate of obstetric lacerations. No statistically significant association was found between the use of epidural analgesia and the occurrence of perineal tears (36.8 vs 36.0%, *P*=.83), vaginal (5.5 vs 7.1%, *P*=.37) or labial trauma (13.9 vs 9.9%, *P*=.11). A statistically significantly higher rate of primiparous women was observed in the group treated with epidural analgesia (73.6 vs 43.8%, *P*=.001). A statistically significantly prolonged second stage of labour was found in women who required epidural analgesia (73 vs 30 min, *P*=.0001). Episiotomy was statistically significantly more frequent in women with epidural analgesia (24.3 vs 12.1%, *P*=.0001). Epidural users were more likely to have labour augmented with oxytocin (67.1 vs 16.9%, *P*=.001). No statistically significant differences in Apgar score <7 (3.5% vs 3.2%, *P*=.84) and cord pH <7.1 (3.0% vs 1.5%, *P*=.23) were observed between the two groups.
Dalbye 2019	Norway	Secondary analysis of a cluster randomized controlled trial	Nulliparous women who had a singleton full-term fetus in a cephalic presentation and spontaneous onset of labor	Zhang's guideline	WHO partograph	7,277 participants	Proportion of oxytocin augmentation in active labor, duration of oxytocin augmentation in minutes, maximum dose of oxytocin in mL/h, dose when initiating augmentation, cervical dilatation when initiating augmentation with oxytocin, proportion of discontinuation of oxytocin, proportion of labor dystocia according to the allocated guideline, cervical dilatation when labor dystocia was diagnosed	Moderate risk of bias	A total of 3,219 women (44%) received augmentation with oxytocin during labor. Oxytocin was used in 1,658 (42%) women in the Zhang group compared with 1,561 (47%) women in the WHO group. The adjusted relative risk for augmentation with oxytocin was 0.98 (95% CI 0.84–1.15; *P*=.8) in the Zhang vs WHO group, with an adjusted risk difference of -0.8% (95% CI -7.8 to 6.1). The participants in the Zhang group were less likely to be augmented with oxytocin before reaching 6 cm of cervical dilatation (24%) compared with participants in the WHO group (28%), with an adjusted relative risk of 0.84 (95% CI 0.75–0.94; *P*=.003). Oxytocin was administered for almost 20 min longer in the Zhang group than in the WHO group, with an adjusted mean difference of 17.9 min (95% CI 2.7–33.1; *P*=.021). In addition, 19% of the women in the Zhang group and 23% in the WHO group received augmentation with oxytocin without being diagnosed with labor dystocia.
Rosenbloom 2019	United States	Secondary analysis of a prospective cohort	Patients at 37 or more weeks presenting in spontaneous or induced labor with a	Dilation time from 4–6 cm	n/a	7,355 patients	Cesarean delivery, maternal morbidity (composite of postpartum fever, wound infection, hemorrhage),	Moderate risk of bias	728 (10%) had dilation times from 4–6 cm greater than 10.3 hours, which was the 90th percentile, and 6,627 (90%) had dilation times greater than 10.3 hours. Having dilation time from 4–6 cm above the 90th percentile (10.3 hours) was associated with cesarean delivery (adjusted odds ratio, 2.05; 95% CI

			nonanomalous living singleton in vertex presentation				and neonatal morbidity (composite of neonatal death, hypothermic therapy, mechanical ventilation, respiratory distress, meconium aspiration syndrome, seizure, or treatment of sepsis)		1.67–2.52), composite maternal morbidity (adjusted odds ratio, 1.48; 95% CI 1.10–2.00), and composite neonatal morbidity (adjusted odds ratio 1.92; 95% CI 1.52–2.4). The area under the receiver operator characteristic curve for predicting cesarean delivery was 0.73 (95% CI 0.71–0.75). The test characteristics for the cutoff of 9.75 hours were sensitivity 68.3% (95% CI 64.8–71.7%), specificity 66.2% (95% CI 55.0–67.3%), positive predictive value 18.5% (95% CI 17.1–20.0%), and negative predictive value 94.9% (95% CI 94.2–95.5%). For composite maternal morbidity, the cutoff was 6.98 hours and the area under the curve was 0.62 (95% CI 0.59–0.65), whereas for composite neonatal morbidity it was 5.5 hours (area under the curve 0.69; 95% CI 0.67–0.71).
Sinkey 2019	United States	Single center retrospective cohort	Low-risk multiparous women delivering nonanomalous singletons 39–42 completed weeks of gestation	Elective induction of labor	Expectant management	3,703 women	Perinatal composite of death, neonatal respiratory support, a 5-minute Apgar score of 3 or less, shoulder dystocia, obstetric triage and office visits at 39 weeks of gestation or more	Moderate risk of bias	453 (12%) delivered 39 0/7–39 4/7 after an elective induction of labor. Women who underwent elective induction of labor were more likely to be privately insured, non-Hispanic, and weigh more at their first prenatal visit (all *P*<.01) compared with expectant management. An elective induction of labor was associated with decreased frequency of the perinatal composite morbidity (4.0% vs 7.1%; adjusted odds ratio [aOR] 0.57, 95% CI 0.34–0.96) compared with expectant management. Fewer cesarean deliveries occurred among women in the elective induction of labor group (5.1% vs 6.6%; aOR 0.60, 95% CI 0.37–0.97). Other maternal outcomes (hypertensive disorders, chorioamnionitis, and operative vaginal deliveries) as well as neonatal intensive care unit admissions were not different between groups.
Angeby 2018	Sweden	Descriptive and comparative study	Women who intended vaginal births and who had spontaneous onset of labor at 37 or more weeks' gestation	Latent phases lasting less than 18 hours	Latent phases lasting 18 hours or more	1,343 women	Obstetric interventions, labor, neonatal outcomes	Serious risk of bias	Prolonged latent phase lasting 18 hours or more occurred in 23% of all births analyzed (n=1,343). A prolonged latent phase was more common among nulliparous women (29.2%) but also common for multiparous women (17%). Nulliparous and multiparous women who experienced a prolonged latent phase were more often exposed to amniotomy during latent phase. For nulliparous women, the adjusted odds ratio (aOR) was 11.57 (95% CI 5.25–25.51) and for multiparous women the aOR was 18.73 (95% CI 9.06–38.69). Similarly, amniotomy during active phase was more common for both nulliparous and multiparous women who experienced a prolonged latent phase (aOR, 4.05; 95% CI 2.53–6.47 and aOR, 3.93; 95% CI 2.43–6.37, respectively). Women with latent phases of 18 hours or more, more often

									experienced augmentation of labor during all phases, especially during latent phase. For nulliparous women, the aOR was 10.13 (95% CI 2.82–36.39) and for multiparous women, aOR was11.9 (95% CI 3.69–38.71). A prolonged latent phase was associated with more instrumental vaginal births for multiparas (aOR, 2.58; 95% CI 1.27–5.26) and emergency cesarean regardless of parity (nulliparous women: aOR, 3.21; 95% CI 1.08–9.50 and multiparous women: aOR 3.93; 95% CI 1.67–9.26).
Clapp 2018	United States	Database analysis	Women with hospital delivery	High- and low-risk patients in low-acuity centers	High- and low-risk patients in high-acuity centers	1,656,659 women	Obstetric outcomes	Serious risk of bias	There were 58.7% low-risk, 39.0% intermediate-risk, and 2.3% high-risk patients in the overall sample, and the overall rate of severe maternal morbidity was 1.2%. Less than 3.7% of delivering patients in low-acuity hospitals had a high-risk condition. In comparison, more than 7.1% patients in high-acuity centers had a high-risk condition. In the adjusted analysis, intermediate-risk patients had a slightly increased risk of morbidity in both low-acuity and high-acuity centers compared with low-risk patients (adjusted risk ratios, 1.53 [95% CI 1.33–1.77] vs 1.57 [95% CI 1.49–1.65]). However, there was a notable difference in the adjusted risk ratios for severe maternal morbidity in the high-risk population: the adjusted risk ratio was 9.55 (95% CI 6.83–13.35) in low-acuity hospitals compared with 6.50 (95% CI 5.94–7.09) in high-acuity hospitals.
Corry 2018	Ireland	Retrospective cohort	Nulliparous and multiparous women in spontaneous or induced labor	Deliveries by cesarean section at full dilatation in single cephalic pregnancies 34 or more weeks	Deliveries meeting the same criteria who had a successful OVD who were considered at risk of requiring a full dilatation cesarean section	9,186 deliveries	Maternal and neonatal morbidity, duration of admission post CS	Moderate risk of bias	The rate of full dilatation caesarean section increased by over a third in the ten-year period (56/6,947 (0.80%) vs 92/7,378 (1.24%), *P*=.01). Of 84 full dilatation caesarean sections who met the inclusion criteria, 63 (75%) were nulliparous and the mean maternal age was 33 (±5) years. Oxytocin was used in the second stage in less than half of second stage caesarean sections (22 out of a recorded 57, 38.6%). There were more fetal head malposition (occiput posterior, or occiput transverse) at full dilatation caesarean section compared to successful operative vaginal deliveries (41/46 (89.1%) vs 2/21 (9.5), *P*<.001). The rate of significant postpartum hemorrhage (defined as estimated blood loss 1000 ml) was similar in both full dilatation caesarean section and operative vaginal deliveries. There was no difference in the mean birthweight at full dilatation caesarean sections compared to operative vaginal delivery (3.88 kg (2.80–5.33 kg) vs 3.48 kg (1.53–4.40 kg)). There was no difference in neonatal morbidity.

Frolova 2018	United States	Secondary analysis of a retrospective cohort	Women who were admitted for delivery at 37 weeks of gestation or later	Obese women with (BMI) 30 or greater	Non-obese women (BMI less than 30)	11,752 women	Rates of spontaneous labor, vaginal delivery, augmentation with oxytocin	Moderate risk of bias	Obese women had lower rates of spontaneous labor than nonobese women at every gestational week (37 weeks, 6.1 vs. 9.3%, *P*<.001; 38 weeks, 12.8 vs. 19.2%, *P*<.001; 39 weeks 26.0 vs. 37.0%, *P*<.001; 40 weeks, 39.6 vs. 50.2%, *P* <.001; 41 weeks, 30.8 vs. 38.0%, *P*<.012). Among women who presented in spontaneous labor, obesity was associated with higher rates of augmentation with oxytocin and lower rates of vaginal delivery.
Hautakangas 2018	Finland	Retrospective case-control	Term primiparous women	Term primiparous women whose intended vaginal labor ended in acute CS because of dystocia	Primiparas with successful vaginal delivery	598 women	Labor outcome, neonatal outcome	Moderate risk of bias	In the cases ending with acute CS, women were older (OR 1.06 [1.03–1.10]), shorter (OR 0.94 [0.91–0.96]) and more often had a chronic disease (OR 1.60 [1.1–2.29]). In this group fetal malposition (OR 42.0 [19.2–91.9]) and chorioamnionitis (OR 10.9 [5.01–23.6]) were more common, labor was less often in an active phase (OR 3.37 [2.38–4.76]) and the cervix was not as well ripened (1.5 vs. 2.5 cm, OR 0.57 [0.48–0.67] on arrival at the birth unit. BMI was higher in the dystocia group (24.1 vs. 22.6 kg/m2, *P*<.001), and rising maternal pre-pregnancy BMI had a strong association with dystocia risk. If BMI increased by 1 kg/m2, the risk of CS was 10% elevated. Among obese primiparas, premature rupture of membranes, chorioamnionitis and induction of labor were more common. Their labors were less often in an active phase at hospital admission. Severely obese primiparas (BMI ≥ 35 kg/m2) had 4 hours longer labor than normal weight parturients.
Hoppe 2018	United States	Retrospective cohort	Nulliparous, 18 to 44 years, with a cephalic, singleton and 37 weeks or more in spontaneous labor	Active labor duration from 6–10 cm as less than the median based on contemporary labor curves published by Zhang et al	Active labor duration as he median-95th, and greater than 95th percentile based on contemporary labor curves published by Zhang et al	642 women	Cesarean delivery, chorioamnionitis, estimated blood loss, Apgar score less than 7 at 5 minutes, NICU admission	Moderate risk of bias	Compared with women whose active labor was less than the median, the risk of cesarean was higher in the median-95th percentile ([adjusted OR, aOR] 3.1, 95% CI 1.8–5.5) and the greater than 95th percentile ([aOR] 6.8, 95% CI 3.9–11.7) subgroups. There was an increased odds of chorioamnionitis in the median-95th percentile subgroup ([aOR] 2.5, 95% CI 1.1–5.9).
Juhasova 2018	Switzerland	Retrospective cohort	Women with singleton pregnancies in vertex presentation with a vaginal delivery at 34 + 0 to 42 +	Standard obstetrical care	n/a	8,378 women	Cervical dilation rates in the active phase of labor	Moderate risk of bias	Cervical dilation rates increase during labor progress with faster rates in multiparous compared with nulliparous women (*P*<.001). Dilation rates exceed 1 cm/h at a dilatation of 6–7 cm but are very individual. Accelerating impact factors are multiparity, a greater amount of cervical dilation and fetal occiput anterior position, whereas the use of epidural anesthesia, a

			5 gestational weeks						higher fetal weight and head circumference decelerate dilation (*P*<.001).
Kozhimannil 2018	United States	Retrospective cohort	Births in US rural counties	Loss of hospital-based obstetric services in the county of maternal residence	n/a	4,941,387 births	County rates of (1) out-of-hospital births; (2) births in hospitals without obstetric units; and (3) preterm births	Serious risk of bias	Between 2004 and 2014, 179 rural counties lost hospital-based obstetric services. Of the 4,941,387 births studied, the mean (SD) maternal age was 26.2 (5.8) years. A mean (SD) of 75.9% (23.2%) of women who gave birth were non-Hispanic white, and 49.7% (15.6%) were college graduates. Rural counties not adjacent to urban areas that lost hospital-based obstetric services had significant increases in out-of-hospital births (0.70 percentage points [95% CI 0.30–1.10]); births in a hospital without an obstetric unit (3.06 percentage points [95% CI 2.66–3.46]); and preterm births (0.67 percentage points [95% CI 0.02–1.33]), in the year after loss of services, compared with those with continual obstetric services. Rural counties adjacent to urban areas that lost hospital-based obstetric services also had significant increases in births in a hospital without obstetric services (1.80 percentage points [95% CI 1.55–2.05]) in the year after loss of services, compared with those with continual obstetric services, and this was followed by a decreasing trend (−0.19 percentage points per year [95% CI −0.25 to −0.14]).
Lewkowitz 2018	United States	Secondary analysis of a prospective cohort	Term singleton pregnancies	Early epidurals (placed at less than 6 cm)	Late epidurals (placed at 6 cm or later)	7,647 women	Median fetal station from 6–10 cm, rate of prolonged first or second stage of labor	Moderate risk of bias	Interquartile ranges (IQRs) suggested fetal stationat6cmwas likely lower among those with early epidurals (nulliparous: median head station –1 [IQR: –1 to 0] for early epidural vs.–1 [IQR: –2 to 0] for late epidural, *P*<.01; multiparous: –1 (IQR: –2 to 0] for early epidural vs. –1 [IQR: –3 to –1] for late epidural, *P*<.01). Early epidurals were not associated with increased risk of prolonged first stage, but among nulliparous were associated with decreased risk of prolonged second stage (adjusted odds ratio: 0.66 [95% CI 0.44–0.99]).
Mason 2018	United States	Retrospective cohort	Term multiparas	Grouped by interval between the studied pregnancy and the most recent birth: 0 to 59, 60 to 119, and ≥120 months.	Comparisons between groups	250 charts	Length of second stage	Moderate risk of bias	Groups did not differ significantly in demographic or obstetrical characteristics. Rate of dilation was similar between the 0 to 59 and 60 to 119 month groups (*P*=.38), but faster in the ≥120 month group compared with the 60 to 119 month group (*P*=.037). Median duration of second stage increased slightly with increased interbirth interval (*P*=.003).

Thuillier 2018	France	Retrospective cohort	Women with singleton pregnancies at ≥37 weeks' gestation, in vertex presentation, in spontaneous or induced labor, and with epidural anesthesia	After labor management guideline implementation	Before labor management guideline implementation	3,283 and 3,068 women in the before and after periods	Maternal and neonatal outcomes, rate of primary cesarean delivery	Moderate risk of bias	The groups had similar general and obstetric characteristics. The global cesarean delivery rate decreased significantly from 9.4% in the preguideline to 6.9% in the postguideline period (odds ratio, 0.71; 95% CI 0.59–0.85; *P*<.01). The cesarean delivery rate for arrest of first-stage labor fell by half, from 1.8% to 0.9% (odds ratio, 0.51; 95% CI 0.31–0.81; *P*<.01) but was significant only among nulliparous women. The cesarean delivery rate for second-stage arrest of labor decreased but not significantly between periods (1.3% vs 1.0%; odds ratio, 0.73; 95% CI 0.44–1.22; *P*=.2), and the cesarean delivery rate for failure of induction remained similar (3.7% vs 3.5%; odds ratio, 1.06; 95% CI 0.06–13.24; *P*=.88). The median duration of labor before cesarean delivery also became significantly longer among nulliparous women during the later period. Maternal and neonatal outcomes did not differ between the 2 periods, except that the rate of 1 minute Apgar score <7 fell significantly in the later period (8.4% vs 6.9%; odds ratio, 0.80; 95% CI 0.66–0.97; *P*=.02).
Gunnarsson 2017	Norway	Retrospective analysis	Multiparous women, in spontaneous labor, no previous Cesarean section, gestational age 37 weeks or later, and single, cephalic pregnancy	Partogram	n/a	1,753 partograms	Time from each cervical measurement to full dilation	Moderate risk of bias	The strongest predictors were birthweight, epidural and oxytocin use, and spontaneous rupture of membranes, along with cervical measurements. For birthweight, there was an almost 40% increase in time to full cervical dilation for each 1-kg increment. Conditional time was on average 23% longer in cases with epidural use and 53% longer in cases requiring oxytocin augmentation. Spontaneous rupture of the membranes shortened conditional time by 31%. Maternal age was not associated with the outcome, while increasing BMI and parity modestly reduced conditional time.
Nyflot 2017	Norway	Case-control	Women admitted for labor at gestational week 23 or later	Severe PPH as postpartum blood loss 1500 mL or more within 24 hours of delivery of the infant or the need for blood transfusion for excessive bleeding at the time of delivery	Without severe PPH	2,614 women	Duration of each stage of active labor	Moderate risk of bias	Observed a significantly longer mean duration of labor in women who experienced severe postpartum hemorrhage compared to controls (5.4 versus 3.8 hours, *P*<.001). Women with severe postpartum hemorrhage also had a longer duration of all stages of active labor compared to controls. The association between the duration of active labor and severe postpartum changed from a linear dose-response association to a threshold association after adjusting for augmentation with oxytocin, induction of labor, primiparity, and fever during labor. Compared to controls, women with severe postpartum hemorrhage were more likely to have a prolonged labor 12 hours or more (adjusted odds ratio = 2.44, 95% CI 1.69±3.53, *P*<.001).

Ostborg 2017	Norway	Observational cohort	Nulliparous and parous women with spontaneous and induced births	Active management	n/a	19,524 women	Duration of active phase of labor	Moderate risk of bias	The active phase was longer in induced labors than in labors with spontaneous onset in nulliparous women. The estimated median duration using survival analyses was 433 min (95% CI 419–446) in spontaneous vs. 541 min (95% CI 502–580) in induced labors [unadjusted hazard ratio 0.76 (95% CI 0.71–0.82) and adjusted hazard ratio 0.88 (95% CI 0.82–0.95)]. In parous women, a one minus survival plot showed that induced labors had shorter duration before six hours in active labor, but after six hours, induced labors had longer duration. The overall difference in parous women was small and probably of little clinical importance.
Poma 2017	Italy	Longitudinal cohort	Nulliparas with a singleton pregnancy in cephalic presentation at term	Induced labor and epidural analgesia	Spontaneous labor and epidural analgesia	1,104 women	Length of first stage labor, duration of transition, duration of second stage, mode of delivery, blood loss, perineal outcome, neonatal measures	Moderate risk of bias	The only significant difference found was duration of the first stage, which lasted 305 (200–390) min in spontaneous labor compared to 205 min (120–345) in induced labor (*P*<.001).
Hauth 1986	United States	Quantitative analysis	Pregnant women at term with occiput presentation who required oxytocin or augmentation of labor	Oxytocin for induction of labor	Oxytocin for augmentation	109 women	Uterine contraction pressure	Moderate risk of bias	Women who received oxytocin for induction of labor had significantly higher uterine contraction pressures than did women who required oxytocin for augmentation.
Caldeyro Barcia 1959	New York	Quantitative analysis	Women <30 weeks of gestation	Uterine contractility by amniotic fluid pressure	-	500 women	Intensity of contractile wave	Moderate risk of bias	The uterine response to the continuous intravenous infusion of oxytocin increases with the age of pregnancy, reaches almost its maximum values at the thirty-sixth week, and shows no significant changes between the thirty-sixth and fortieth weeks and during labor.
Rosenbloom 2017	United States	Secondary analysis of a prospective cohort	Patients at 37 weeks or later presenting in spontaneous or induced labor with a nonanomalous living singleton in vertex presentation	Dilation time and time in second stage prior to diagnosis of arrest	Comparison by year	7,845 patients	Rates of CD per year, indications for CD, average cervical dilation at CD for arrest of dilation over the course of the study, adverse neonatal and maternal outcomes	Moderate risk of bias	The CD rate in 2010 was 15.8% and in 2014 17.7% (*P*-trend 0.51). In patients undergoing CD for arrest of dilation, the median cervical dilation at the time of CD was at 5.5 cm in 2010 and 6.0 cm in 2014 (*P*-trend 0.94). In these patients, there was an increase in the time spent at last dilation: 3.8h in 2010 to 5.2h in 2014 (*P*-trend 0.02). There was no change in the frequency of patients diagnosed with arrest of dilation at less than 6 cm: 51.4% in 2010 and 48.6% in 2014 (*P*-trend 0.56). However, in these patients, the median time spent at the last cervical dilation was 4.0 hours in 2010 and 6.7 hours in 2014 (*P*-trend 0.046). There

									were 206 CDs for arrest of descent. The median pushing time in these patients increased in multiparous patients from 1.1 hours in 2010 to 3.4 hours in 2014 (*P*-trend 0.009); in nulliparous patients these times were 2.7 hours in 2010 and 3.8 hours in 2014 (*P*-trend 0.09). There was a significant trend towards increasing adverse neonatal and maternal outcomes (*P*<.001 for each). The aOR for adverse maternal outcome for 2014 compared to 2010 was 1.66 (95% CI 1.27–2.17); however, considering only transfusion, hemorrhage, or infection, there was no difference (*P*-trend 0.96). The aOR of adverse neonatal outcome in 2014 compared to 2010 was 1.80 (95% CI 1.36–2.36).
Sandstrom 2017	Sweden	Population-based cohort	Nulliparous women with singleton infants born in cephalic presentation at ≥ 37 gestational weeks	Duration of second stage of labor (categorized into five groups: 0 to 59 min (<1 h, reference), 60 to 119 min (1 to <2 h), 120 to 179 min (2 to <3 h), 180 to 239 min (3 to <4 h) and ≥ 240 min (≥ 4 h)); duration of pushing (categorized into 5 groups: 0 to 14 (reference), 15 to 29, 30 to 44, 45 to 59 and ≥60 min)	Comparisons between groups	42,539 women	Umbilical artery acidosis, birth asphyxia-related complications, admission to neonatal intensive care unit	Moderate risk of bias	Overall rates of umbilical artery acidosis, birth asphyxia-related complications and admission to NICU were 1.08, 0.63 and 6.42%, respectively. Rate of birth asphyxia-related complications gradually increased with duration of second stage: from 0.42% at <1 h to 1.29% at ≥4 h (adjusted RR 2.46 (95% CI 1.66–3.66)). For admission to NICU, corresponding rates were 4.97 and 9.45%, and adjusted RR (95% CI) was 1.80 (95% CI 1.58–2.04). Compared with duration of pushing o15 min, a duration of pushing ≥ 60 min increased rates of acidosis from 0.57 to 1.69% (adjusted RR 2.55 (95% CI 1.51–4.30)).
Hamilton 2016	United States	Retrospective cohort	Women with singleton cephalic presentations at 37 weeks' gestation or later with electronic fetal monitoring tracings, who delivered	Examination of fetal station and cervical dilation (nullipara and multipara)	n/a	28,121 exams from 5,555 women	Relationship between station and dilation	Moderate risk of bias	A linear relationship was observed between station and dilation. For both nulliparous and multiparous women the final model was a linear regression with random effects for intercept and slope and a first order autoregressive correlation structure. The 5–-95th range of station at any given dilation spanned about 3–4 cm.

			vaginally without instrumentation						
Grobman 2016	United States	Secondary analysis of observational study	Women with no prior cesarean delivery who had a term, singleton, cephalic gestation and reached complete dilation	Duration of active pushing in 60-minute increments: < 1 hour, 1 to < 2 hours, 2 to < 3 hours, 3 to < 4 hours, and ≥ 4 hours	Comparison between increments	53,285 women	Cesarean delivery, neonatal outcome composite (mechanical ventilation, proven sepsis, brachial plexus palsy, clavicular fracture, skull fracture, other fracture, seizures, hypoxic ischemic encephalopathy, or death)	Moderate risk of bias	In both nulliparous and parous women, longer duration of pushing was associated with increased odds of both cesarean delivery and the neonatal adverse outcome composite. Nevertheless, even after 4 hours of pushing, approximately 78% of nulliparous women who continued with active pushing had a vaginal delivery and over 97% did not have the composite adverse neonatal outcome. Similarly, after more than 2 hours of pushing, approximately 82% of parous women who continued active pushing delivered vaginally and over 97% did not have the adverse neonatal outcome.
Kauffman 2016	United States	Retrospective cohort	Singleton, term (37–43 6/7 weeks of gestation) spontaneously laboring women	Early (less than 4 cm cervical dilation) admission	Late (4 cm or greater cervical dilation) admission	11,368 women	Duration of labor, mode of delivery, cesarean delivery, operative vaginal delivery, Hemorrhage, trauma to the pelvic floor; admission to NICU	Moderate risk of bias	Early admission compared with late admission was associated with increased epidural use of 84.8% compared with 71.8% in nulliparous women and 66.3% compared with 53.1% in multiparous women (nulliparous RR 1.18, 95% CI 1.13–1.24; multiparous RR 1.25, 95% CI 1.18–1.32); oxytocin augmentation in 58.5% compared with 36.6% in nulliparous women and 45.9% compared with 20.7% in multiparous women (nulliparous RR 1.56, 95% CI 1.50–1.63; multiparous RR 2.14, 95% CI 1.87– 2.44); and cesarean delivery of 21.8% compared with 14.5% in nulliparous women and 3.7% compared with 1.9% in multiparous women (nulliparous RR 1.50, 95% CI 1.32–1.70; multiparous women RR 1.95, 95% CI 1.47–2.57). Early admission was associated with increased neonatal intensive care unit admission for newborns of nulliparous women only (RR 1.38, 95% CI 1.01–1.89). Between 2012 and 2014, late admission increased 14.6% for nulliparous patients and 10.1% for multiparous patients, and the cesarean delivery rate decreased from 10.5% to 7.9% (*P*<.001) for all.
Eggebo 2015	Norway and United Kingdom	Prospective observational	Nulliparous pregnant women with a singleton cephalic presentation at term and prolonged labor	Ultrasound assessment of fetal head position	n/a	150 women	Cesarean section vs vaginal delivery, operative vaginal delivery, remaining time in labor	Moderate risk of bias	Fetal head position was assessed successfully by ultrasound examination in 142/150 (95%) women. In total, 19/50 (38%) women with a fetus in the occiput posterior (OP) position were delivered by Cesarean section compared with 16/92 (17%) women with a fetus in a non-OP position (*P*=.01). On multivariable logistic regression analysis, the OP position predicted delivery by Cesarean section with an odds ratio (OR) of 2.9 (95% CI 1.3–6.7; *P*=.01) and induction of labor with an OR of 2.4 (95% CI 1.0–5.6; *P*=.05). Fetal head position was not associated with operative

									vaginal delivery or with remaining time in labor. The agreement between a digital and an ultrasound assessment of OP position was poor (Cohen's kappa=0.19; *P*=.18).
Harper 2014	United States	Retrospective cohort	Women admitted at a gestation of 37.0 weeks or longer who reached second stage of labor	First stage above each centile	First stage below each centile	5,030 women	Cesarean delivery in the second stage, operative delivery, prolonged second stage, postpartum hemorrhage, maternal fever, neonatal outcome composite	Moderate risk of bias	Of the 5,030 women, 4,534 experienced first stage of less than the 90th percentile, 251 between the 90th and 94th percentiles, 102 between the 95th and 96th percentiles, and 143 at the 97th percentile or greater. Longer labors were associated with an increased risk of a prolonged second stage, maternal fever, the composite neonatal outcome, shoulder dystocia, and admission to a level 2 or 3 nursery (*P*<.01). Depending on the cutoff used, 29–30 cesarean deliveries would need to be performed to prevent 1 shoulder dystocia.
Graseck 2014	United States	Retrospective cohort	Consecutive term, vertex singletons who delivered vaginally	Spontaneous	Induced or augmented	4,618 deliveries	Fetal descent	Moderate risk of bias	Of 4,618 consecutive-term spontaneous vaginal deliveries, 1,526 (33%) were nulliparous. Sixty-one percent were augmented or induced. Multiparous women had faster fetal descent at all stations except from +2 to +3 station. The median time to descend from one station point to another ranged from 0.1 to 1.6 hours, but the 95th percentiles encompassed over 12 hours at the same high-station among nulliparous women who achieved vaginal delivery. Fetal descent was more rapid in women who labored spontaneously without augmentation. Multiparous women tended to have a higher station than nulliparous women until late in the first stage.
Laughon 2014	United States	Analysis of retrospective cohort	Multiparous and nulliparous women with singleton deliveries 36 weeks or later, vertex presentation, who reached 10 cm cervical dilation	Prolonged second stage definitions: nulliparous women with epidural more than 3 hours, without more than 2 hours; multiparous women with epidural more than 2 hours, without more than 1 hour	Between defined groups	103,415 women	Postpartum hemorrhage, blood transfusion, cesarean hysterectomy, endometritis, ICU admission, chorioamnionitis, wound infection, wound separation, episiotomy, 3rd or 4th degree perineal laceration, cervical laceration and hospital length of stay, shoulder dystocia, 5-minute Apgar less than 4, need for continuous positive airway pressure (CPAP) resuscitation or	Moderate risk of bias	Prolonged second stage occurred in 9.9% and 13.9% of nulliparous and 3.1% and 5.9% of multiparous women, with and without an epidural, respectively. Vaginal delivery rates with prolonged second stage compared to within guidelines were 79.9% versus 97.9% and 87.0% versus 99.4% for nulliparous women with and without epidural, respectively, and 88.7% versus 99.7% and 96.2% versus 99.9% for multiparous women with and without epidural, respectively (*P*<.001 for all comparisons). Prolonged second stage was associated with increased chorioamnionitis and third-degree or fourth-degree perineal lacerations. Neonatal morbidity with prolonged second stage included sepsis in nulliparous women [with epidural: 2.6% versus 1.2% (aOR 2.08; 95% CI 1.60–2.70); without epidural: 1.8% versus 1.1% (aOR 2.34; 95% CI 1.28–4.27)]; asphyxia in nulliparous women with epidural [0.3% versus 0.1%, aOR 2.39; 95% CI 1.22–4.66]; and perinatal mortality without epidural [0.18% versus 0.04% for nulliparous women (aOR 5.92; 95% CI 1.43–24.51)], and 0.21% versus 0.03% for multiparous women (aOR 6.34; 95% CI 1.32–

							higher, NICU admission, sepsis, pneumonia, hypoxic-ischemic encephalopathy/ periventricular leukomalacia (HIE/PVL), seizure, intracranial hemorrhage/periventricular hemorrhage (ICH/PVH), asphyxia, perinatal death		30.34)]. However, among the offspring of women with epidurals whose second stage was prolonged (3,533 nulliparous and 1,348 multiparous women), there were no cases of hypoxic ischemic encephalopathy or perinatal death.
Neal 2014	United States	Prospective analysis	Low-risk, nulliparous women with spontaneous labor onset at term gestation	Preactive labor admission group	Active labor admission group	216 women	Labor intervention, maternal and neonatal outcomes	Serious risk of bias	114 (52.8%) were admitted in preactive labor and 102 (47.2%) were admitted in active labor. Women who were admitted in preactive labor were more likely to undergo oxytocin augmentation (84.2% and 45.1%, respectively; odds ratio [OR], 6.5; 95% CI 3.43–12.27) but not amniotomy (55.3% and 61.8%, respectively; OR, 0.8; 95% CI 0.44–1.32) when compared to women admitted in active labor. The likelihood of cesarean birth was higher for women admitted before active labor onset (15.8% and 6.9%, respectively; OR, 2.6; 95% CI 1.02–6.37).
Spain 2014	United States	Retrospective cohort	Women admitted with viable (≥ 24 weeks) vertex singleton gestations who reached the second stage of labor	Preterm labor	Term labor	5,612 births	Labor curves, median time for progression of labor	Moderate risk of bias	Preterm first-stage labor progressed significantly faster than term labor (median time 4 to 10 cm: 3.3 hours versus 4.5 hours, *P*<.01). When stratified by parity, preterm labor progressed significantly more rapidly than term labor in both nulliparous and multiparous women (median time 4 to 10 cm: 3.7 hours versus 4.9 hours [*P*=.04] in nulliparous women and 2.5 hours versus 4.3 hours [*P*=.01] in multiparous women).
Carlhall 2013	Sweden	Historical prospective cohort	Nulliparous women with a singleton pregnancy and a spontaneous onset of labor	Duration of labor in overweight and obese women	Duration of labor in normal weight women	63,829 women	Duration of the active phase of labor, risk of labor 12 hours or later and risk of labor 12 hours or later or emergency cesarean section, duration of the second stage of labor	Moderate risk of bias	The median duration of labor was significantly longer in obese women (class I obesity (BMI 30–34.9) = 9.1 hours, class II obesity (BMI 35–39.9) = 9.2 hours and class III obesity (BMI greater than 40) = 9.8 hours) compared to normal-weight women (BMI 18.5–24.9) = 8.8 hours (*P*<.001). The risk of labor lasting more than 12 h increased with increasing maternal BMI: OR 1.04 (1.01–1.06) (OR per 5-units BMI-increase). The risk of labor lasting more than 12 hours or emergency cesarean section within 12 hours, compared to vaginal deliveries within 12 hours, increased with increasing maternal BMI. Duration of the second stage of labor was significantly shorter in obese women: in class III obesity the median value was 0.45 hours compared to normal weight women, 0.55 hours (*P*<.001).

Ghi 2013	Italy	Prospective	Nulliparous women	Spontaneous vaginal delivery (Group A)	Operative delivery (Group B)	71 women	Angle of progression	Moderate risk of bias	When compared with Group B, Group A had a wider AoP only at T1 (140.0 ± 20.2◦ vs 122.9 ± 16.7◦; *P*=.010) and T2 (149.7 ± 20.7◦ vs 126.9 ± 17.5◦; *P*=.006). MLA was narrower in Group A only at T3 (21.2 ± 11.7◦ vs 40.8 ± 27.9◦; *P*=.043), T4 (18.2 ± 15.0◦ vs 47.4 ± 29.6◦; *P*=.020) and T5 (18.3 ± 6.0◦ vs 34.7 ± 4.2◦; *P*=.034). On stepwise forward multiple logistic regression analysis, both AoP and MLA were independently associated with operative delivery (OR=0.955 and OR=1.018, respectively).
Nelson 2013	United States	Observational	Nulliparous women with a singleton, cephalic live birth at 37 0/7 weeks of gestation or more	Standardized protocol for labor management	n/a	12,523 women	Time intervals for the durations of the first and second stages of labor, maternal habitus, use of epidural analgesia, route of delivery, neonate birth weight	Moderate risk of bias	The 95th percentile was 15.6 and 2.9 hours for the first and second stages, respectively. Women with first stages greater than the 95th percentile had a 16.3% rate of a second-stage length greater than the 95th percentile compared with 4.5% (*P*<.001) in women with first stages less than the 95th percentile. This relationship persisted when analyzed for variables influencing labor to include neonate birth weight, epidural analgesia, or maternal size.
Bleich 2012	United States	Retrospective cohort analysis	Nulliparous women reaching the second stage of labor who delivered a live-born infant at ≥ 37 weeks' gestation	Duration of second stage ≥ 3 hours	Duration of second stage < 3 hours	21,991 pregnancies	Management decisions in women with second stages ≥4 hours, maternal and neonatal morbidity	Moderate risk of bias	Second stage exceeding 3 hours occurred in 1,489 (7%) of 21,991 pregnancies analyzed. Of the 427 (2%) with second stages ≥4 hours, 315 (74%) reached 4 hours unintentionally, after a decision for operative delivery had been made. Only 34 (8%) women were intentionally allowed to continue second-stage labor beyond 4 hours, and half of these ultimately required cesarean. Indices of maternal and neonatal morbidity were significantly increased when second stages exceeded 3 hours.
Callaghan 2012	United States	Database analysis	All delivery and postpartum hospitalizations	Algorithm incorporating ICD-9-CM diagnosis codes for an outcome of delivery, diagnosis-related groups delivery codes, and ICD-9-CM procedure codes for selected delivery related procedures	n/a	49,346,974 deliveries, 738,124 postpartum hospitalizations	Complications, morbidity	Serious risk of bias	Severe morbidity rates for delivery and postpartum hospitalizations for the 2008–2009 period were 129 and 29, respectively, for every 10,000 delivery hospitalizations. Compared with the 1998–1999 period, severe maternal morbidity increased by 75% and 114% for delivery and postpartum hospitalizations, respectively. We found increasing rates of blood transfusion, acute renal failure, shock, acute myocardial infarction, respiratory distress syndrome, aneurysms, and cardiac surgery during delivery hospitalizations. Moreover, during the study period, rates of postpartum hospitalization with 13 of the 25 severe complications examined more than doubled, and the overall mortality during postpartum hospitalizations increased by 66% (*P*<.05).

Cahill 2012	United States	Retrospective cohort	Singleton term labor patients who delivered in the second stage	Active phase of first-stage labor	Comparisons between gender (male vs female)	2,373 women	Length of active stage 1	Moderate risk of bias	Male gender was associated with both a statistically significantly longer active first stage of labor (4.6 vs 4.0 hours; *P*=.002) and stratified analyses by parity and labor type.
Harper 2012	United States	Retrospective cohort	Women admitted for labor at 37 weeks or more of gestation	Induced labor, augmented labor	Spontaneous labor without augmentation	5,388 women	Duration and curves of the first stage of labor	Moderate risk of bias	After adjusting for race, obesity, macrosomia, and Bishop score, women who were induced had a significantly longer total time in labor than women who labored spontaneously (median [95th percentile] in hours for nulliparous women: 5.5 [16.8] induced compared with 3.8 [11.8] spontaneous; for multiparous women 4.4 [16.2] induced compared with 2.4 [8.8] spontaneous). However, median time to progress 1 cm dilation in active labor (6 cm or greater) was similar in induced and spontaneous labor. The time to progress 1 cm dilation in latent labor (less than 6 cm) was significantly longer in women who were induced compared with women who experienced spontaneous labor.
Kyser 2012	United States	Database analysis	Maternal childbirth admissions	Cesarean delivery	Normal spontaneous vaginal delivery	1,683,754 childbirths	Hemorrhage, severe perineal lacerations, operative complications, infection, thrombotic complications, death	Serious risk of bias	Decile 1 and 2 hospitals had significantly higher rates of composite complications than decile 10 (11.8% and 10.1% vs 8.5%, respectively; *P*<.0001). Decile 9 and 10 hospitals had modestly higher composite complications as compared with decile 6 (8.8% and 8.5% vs 7.6%, respectively; *P*<.0001). Sixty percent of decile 1 and 2 hospitals were located within 25 miles of the nearest greater volume hospital.
Norman 2012	United States	Retrospective cohort	Parturients with singleton term pregnancies (37 weeks of gestation or more) and vertex presentation who completed the first stage of labor	Body mass index (BMI) less than 30	BMI 30 or more	5,204 parturients	Duration and progression of labor	Moderate risk of bias	The labor curves indicate longer duration and slower progression of the first stage of labor among women with BMIs of 30 or more for both nulliparous and multiparous women. Multivariable interval-censored regression analysis confirmed significantly longer duration (4–10 cm: 4.7 compared with 4.1 hours, *P*<.01) and slower progression of cervical dilation from 4 to 6 cm (2.2 compared with 1.9 hours, *P*<.01 with a range of 0.5–10.0 hours) among women with BMIs of 30 or more after adjusting for confounders.
Stewart 2012	United States	Prospective cohort	Women 37 weeks' gestation or later undergoing misoprostol induction of labor	FHR tracing, then divided into four groups based on the greatest number of contractions within any 10-minute epoch during the	Between groups	584 women	Infant condition at birth assessed using a composite outcome termed the fetal vulnerability composite, which included: 5-minute Apgar scores, umbilical artery blood pH, intubation in the	Moderate risk of bias	Adverse infant outcomes showed no association with increasing number of contractions per 10 minutes. Six or more contractions in 10 minutes were significantly associated with fetal heart rate decelerations (*P*≤.001). Analysis was performed using the maximum number of contractions per 30 minutes with similar results.

				initial 4 hours of labor induction: 4 or less, 5, 6, 7 or more contractions per 10 minutes			delivery room, neonatal seizures, admission to intensive care, or perinatal death		
Cheng 2011	United States	Retrospective cohort	Nulliparas with term, singleton, vaginal deliveries beyond the first hour of second stage	Operative vaginal deliveries (OVD) during 1–3 hours of the second stage	Vaginal delivery but with a second stage duration of greater than 3 hours	3,380 nulliparas	Timing, mode of delivery, 5-min Apgar, UA pH, birth trauma, cephalohematoma, brachial plexus injury, NICU admission, perineal laceration, PPH, blood transfusion, chorioamnionitis, endomyometritis, shoulder dystocia	Moderate risk of bias	Nulliparas delivered vaginally beyond 3 hours of second stage had lower odds of third or fourth degree perineal lacerations (aOR=0.63, 95% CI 0.51–0.77), neonatal cephalohematoma (aOR=0.48, 95% CI 0.28–0.83) and admissions to intensive care nursery (aOR=0.70, 95% CI 0.49–0.99) compared to operative vaginal deliveries during 1–3 hours of second stage.
Frigo 2011	Italy	Perspective cohort	Nulliparous parturients	Epidural	Combined spinal epidural (CSE) analgesia	600 parturients	Cervical dilatation rate, second stage durations	Moderate risk of bias	The mean duration of the first stage was 4 h and 30 min (SD 1.52 h) and the mean duration of the second stage was 1 h and 10 min (SD 0.43). In the second stage, the CSE analgesia labors showed an overall faster progression compared to the epidural labors but both lasted longer than the duration reported by Zhang (53 min) and Friedman (39 min). Both the first and the second-stage duration were significantly lower if neuraxial analgesia was performed as a CSE procedure with respect to the simple epidural procedure (first stage 4 hours and 1 min vs 4 hours and 60 min, *P*=.043; second stage 1 hour and 5 min vs 1 hour and 15 min, *P*=.0356).
Incerti 2011	Italy	Retrospective cohort	Nulliparous women with spontaneous labor at term and singleton fetuses in cephalic presentation	Standardized management of labor	n/a	1,119 women	Mode of delivery, duration of labor	Moderate risk of bias	The study sample comprised 1,119 women at 39.7 ± 1.1 weeks with an average duration of labor of 4.1 ± 2.4 hours. The rate of oxytocin use was 27 percent and of epidural analgesia 5 percent. The rate of oxytocin use was inversely related to cervical dilation on admission. Cesarean delivery was performed in 6% of women. Duration of labor at each centimeter of cervical dilation on admission showed a broad distribution (eg, at 4 cm: median=5.5, range: 0.8–12.5 hours). The rate of labor progression (expressed as the slope of the dilation-vs-time curve) was approximately 1.5 cm⁄hr, and it was essentially independent

									of cervical dilation on admission (r=0.034, *P*=0.267). A deceleration phase seemed to be present toward the end of the active phase of labor (approximately 9 cm).
Kominiarek 2011	United States	Repeated-measures analysis	Gravidas with a singleton term cephalic gestation	Body mass index (BMI) categories (normal <25.0 kg/m^2, overweight 25.0– 29.9 kg/m^2, obese Class I 30.0–34.9 kg/m^2, obese Class II 35.0–39.9 kg/m^2, and obese Class III ≥ 40 kg/m^2)	One BMI category versus another	118,978 gravidas	Duration of labor	Moderate risk of bias	For nulliparas, the time difference to reach 10 cm was 1.2 hours from the lowest to highest BMI category. Multiparas entered active phase by 6 cm, but reaching this point took longer for BMI≥40.0 (3.4hours) compared to BMI<25.0 (2.4hours). Progression by centimeter (*P*<.001) except from 7–9cm in multiparas (*P*>.05), and from 4–10cm (*P*<.001) increased as BMI increased for nulliparas and multiparas. Second stage length with and without an epidural was similar among BMI categories for nulliparas (*P*>.05) but decreased as BMI increased for multiparas (*P*<.001).
LeRay 2011	France	Secondary analysis of prospective observational study	Low-risk nulliparous women with vaginal deliveries of cephalic singletons	Active phase of the first stage	Passive and active phases of the second stage of labour	3,330 women	Severe postpartum hemorrhage (PPH)	Moderate risk of bias	The frequency of severe PPH was 2.1% (n=69). In the univariable analysis, severe PPH increased with the duration of the active but not the passive second stage: 1.2% for active second stage <10 min, 1.6% for 10–19 min, 2.1% for 20–29 min, 2.6% for 30–39 min, 4.5% for 40–49 min, and 14.3% for ≥50 min (*P*<.001). After adjustment for confounding factors, the risk of severe PPH was statistically significant when the active first stage exceeded 6 hours (adjusted OR=2.5 [1.0–6.1]) and when pushing lasted longer than 40 minutes (40–49 min: adjusted OR=3.5 [1.0–12.3], ≥50 min: adjusted OR=10.6 [2.8–40.3], reference: <10 min). The duration of expulsive efforts was not associated with other maternal or neonatal complications.
Rouse 2011	United States	Secondary analysis of a randomized multicenter trial	Women undergoing labor induction with an unfavorable cervix according to duration of oxytocin administration in the latent phase of labor after ruptured membranes	Latent phase less than 6 hours	Latent phase of 6 hours or more	1,347 women	Mode of delivery, maternal and neonatal morbidities	Serious risk of bias	Most women had exited the latent phase after 6 hours of oxytocin and membrane rupture; only 5% remained in the latent phase after 12 hours (n=940, 69.8%). The longer the latent phase, the lower the vaginal delivery rate. Even so, 39.4% of the 71 women who remained in the latent phase after 12 hours of oxytocin and membrane rupture were delivered vaginally. Chorioamnionitis, endometritis, or both, and uterine atony were the only maternal adverse outcomes related to latent phase duration: adjusted odds ratios (95% confidence intervals) of 1.12 (1.07, 1.17) and 1.13 (1.06, 1.19), respectively, for each additional hour. Neonatal outcomes were not related to latent phase duration.
Cheng 2010	United States	Retrospective cohort	Nulliparous women with	Length of first stage of labor: less than	Differing lengths of first stage	10,661 nulliparous women	Maternal and neonatal outcomes	Moderate risk of bias	Of the 10,661 nulliparous women meeting study criteria, the median (50th percentile) length of the first stage was 10.5 hours. Compared with women with a

			term, singleton gestations	the 5th percentile, 5th to 95th percentile, and greater than the 95th percentile					first stage between 2.8 and 30 hours (5th to 95th percentile thresholds), the risk of cesarean delivery was higher (6.1% compared with 13.5%; adjusted odds ratio [OR], 2.28, 95% confidence interval [CI] 1.92–2.72) in women with a first stage longer than 30 hours (greater than the 95th percentile). These women also had higher odds of chorioamnionitis (12.5% compared with 23.5%; adjusted OR, 1.58; 95% CI 1.25–1.98) and neonatal admission to the neonatal intensive care unit (4.7% compared with 9.8%; adjusted OR, 1.53; 95% CI 1.18–1.97) but no other associated adverse neonatal outcomes.
Zhang 2010	United States	Repeated-measures analysis	Parturients with singleton term gestation, spontaneous onset of labor, vertex presentation, vaginal delivery, and a normal perinatal outcome	Average labor curves by parity	Parity	62,415 parturients	Duration of labor, labor progression	Moderate risk of bias	Labor may take over 6 hours to progress from 4 to 5 cm and over 3 hours to progress from 5 to 6 cm of dilation. Nulliparas and multiparas appeared to progress at a similar pace before 6 cm. However, after 6 cm labor accelerated much faster in multiparas than in nulliparas. The 95th percentile of the 2nd stage of labor in nulliparas with and without epidural analgesia was 3.6 and 2.8 hours, respectively. A partogram for nulliparas is proposed.
Zhang 2010	United States	Repeated-measures analysis	Parturients with singleton term gestation, spontaneous onset of labor, vertex presentation, and a normal perinatal outcome	Average labor curves by parity	Parity	26,838 parturients	Duration of labor, labor progression	Moderate risk of bias	The median time needed to progress from one centimeter to the next became shorter as labor advanced (eg, from 1.2 hours at 3–4 cm to 0.4 hours at 7–8 cm in nulliparas). Nulliparous women had the longest and most gradual labor curve; multiparous women of different parities had very similar curves. Nulliparas may start the active phase after 5 cm of cervical dilation and may not necessarily have a clear active phase characterized by precipitous dilation. The deceleration phase in the late active phase of labor may be an artifact in many cases.
Allen 2009	Canada	Population-based cohort analysis	Women with low-risk, singleton, vertex, nonanomalous deliveries at or after 37 weeks of gestation	Length of the second stage of labor grouped into five categories for nulliparous women (2 hours or less, more than 2 hours to 3 hours or less, more than 3 hours to 4 hours or less, more	Between groups	121,517 women	Maternal morbidity outcomes, neonatal morbidity outcomes composite outcomes	Moderate risk of bias	There was an increase in risk of maternal obstetric trauma, postpartum hemorrhage, puerperal febrile morbidity and composite maternal morbidity, and low 5-minute Apgar score, birth depression, admission to the neonatal intensive care unit, and composite perinatal morbidity among both nulliparous women and multiparous women, with increasing duration of the second stage of labor. Method of delivery only modified the effect of duration of second stage among nulliparous women.

				than 4 hours to 5 hours or less, and more than 5 hours), and into four categories for multiparous women (1 hour or less, more than 1 hour to 2 hours or less, more than 2 hours to 3 hours or less, and more than 3 hours)					
Henry 2008	United States	Retrospective cohort	Women with term, singleton, cephalic gestations diagnosed with active phase arrest of labor	Active phase arrest who underwent a cesarean delivery; delivered vaginally with active phase arrest	Delivered vaginally; without active phase arrest	1,014 women	Diagnosis of active phase arrest, mode of delivery, frequency of chorioamnionitis, endomyometritis, postpartum hemorrhage, severe postpartum hemorrhage, blood transfusion, Apgar score, acidemia, neonatal sepsis, frequency of admission to NICU	Moderate risk of bias	33% (335) went on to deliver vaginally and the rest were delivered by cesarean. Cesarean delivery was associated with an increased risk of chorioamnionitis (aOR 3.37, 95% CI [2.21–5.15]), endomyometritis (aOR 48.41, [6.61–354]), postpartum hemorrhage (aOR 5.18, [3.42–7.85]), and severe postpartum hemorrhage (aOR 14.97, [1.77–126]). There were no differences in adverse neonatal outcomes. Among women who delivered vaginally, women with active phase arrest had significantly increased odds of chorioamnionitis (aOR 2.70, [1.22–2.36]]), and shoulder dystocia (aOR 2.37, [1.33–4.25]). However, there were no differences in the serious sequelae associated with these outcomes, including neonatal sepsis and Erb's palsy.
Incerti 2008	Italy, United States	Retrospective analysis	Nulliparae in spontaneous labor at greater than 37.0 weeks with singleton fetuses in vertex presentation	Standardized active management of active labor	n/a	1,067 women	Formula for prediction of active labor duration	Moderate risk of bias	Duration of active labor was 4.1 $\pm$ 2.4 hours. Stepwise linear regression selected 10 independent predictors of duration of active labor: gestational age at delivery (*P*<.001), race (*P*=.014), obstetric risk factors (*P*=.022), amniotomy (*P*<.001), fundal height (*P*=.005), cervical dilation on admission (*P*<.001), frequency of contractions (*P*<.001), station of presenting part (*P*<.001), oxytocin (*P*<.001), and epidural use (*P*<.001). A prediction formula incorporating the 10 predictors accounted for 51% of the total variance of the observed duration of active labor.
Cheng 2007	United States	Retrospective cohort	Term, cephalic, singleton births delivered by multiparous women	Duration of the second stage of labor stratified into hourly	Comparisons between intervals	5,158 women	Perinatal outcomes	Moderate risk of bias	Compared with women who delivered between the 0- and 2-hour interval, women with a second stage more than 3 hours had higher risks of operative vaginal deliveries (odds ratio = 13.27; 95% CI 9.38–18.8), cesarean deliveries (odds ratio = 6.00; 4.06–8.86), and

				intervals: 0–1 hour, 1–2 hours, 2–3 hours, and 3 hours or longer					maternal morbidity including third- or fourth-degree perineal lacerations, postpartum hemorrhage, and chorioamnionitis. Their neonates had higher risks of 5-minute Apgar score less than 7 (odds ratio = 3.63; 95% CI 1.77–7.43), meconium stained amniotic fluid (odds ratio = 1.44; 95% CI 1.07–1.94), admission to intensive care nursery (odds ratio = 2.08; 95% CI 1.15–3.77), composite neonatal morbidity (odds ratio = 1.85; 95% CI 1.23–2.77), and longer neonatal stay in the hospital (odds ratio = 1.67; 95% CI 1.11–2.51).
Greenberg 2007	United States	Retrospective cohort	Laboring, term, singleton, and cephalic deliveries	Median lengths of labor	Compared between six age groups and stage of labor	31,976 births	Length of labor	Moderate risk of bias	Among 31,976 births, length of labor differed significantly by maternal age for both nulliparous and multiparous women. Younger nulliparous women (age, <20 years) had a shorter median second stage by up to 97 minutes (*P*<.001) than older nulliparous women (age, >39 years). After we controlled for potential confounders, we found that older women had a persistently higher likelihood of experiencing longer labor and prolonged labor than younger women.
Cheng 2006	United States	Retrospective cohort	Term, cephalic, singleton births	Women with persistent occiput posterior (OP) position at delivery	Women with occiput anterior (OA) position	30,839 births	Length of labor, mode of delivery, third or fourth degree perineal lacerations, postpartum hemorrhage (PPH), severe PPH, chorioamnionitis, endomyometritis	Moderate risk of bias	The overall frequency of OP position was 8.3% in the study population. When compared to Caucasians, a higher rate of OP was observed among African-Americans (OR=1.4, 95% CI 1.25–1.64) while no other racial/ethnic differences were noted. Other associated factors included nulliparity, maternal age 35 or greater, gestational age 41 weeks or greater, and birth weight 44,000 g, as well as artificial rupture of the membranes (AROM) and epidural anesthesia (less than 50.001 for all). Persistent OP was associated with increased rates of operative vaginal (OR=4.14, 95% CI 3.57–4.81) and cesarean deliveries (OR=13.45, 95% CI 11.94–15.15) and other peripartum complications including third or fourth degree perineal lacerations (OR=2.38, 95% CI 2.03–2.79), and chorioamnionitis (OR=2.10, 95% CI 1.81–2.44).
Declereq 2006	United States	Retrospective analysis	Data drawn from 1991 through 2002 US birth certificate files	Primary cesarean rates	Cesarean rates	n/a	Changes in overall and subgroup primary cesarean rates	Serious risk of bias	More than half (53%) of the recent increase in overall cesarean rates resulted from rising primary cesarean rates. There was a steady decrease in the primary cesarean rate from 1991 to 1996, followed by a rapid increase from 1996 to 2002. In 2002, more than one fourth of first-time mothers delivered their infants via cesarean. Changing primary cesarean rates were not related to general shifts in mothers' medical risk profiles. However, rates for virtually every condition listed on birth certificates shifted in the same pattern as with the overall rates.
Bailit 2005	United States	Retrospective cohort	Low-risk women with term, singleton,	Active phase	Latent phase	8,818 women	Labor outcomes	Moderate risk of bias	More latent phase women were nulliparous (51% compared with 28%). Latent phase women had more cesarean deliveries (nulliparas 14.2% compared with 6.7%, multiparas 3.1% compared with 1.4%).

			vertex gestations						Controlling for parity, latent phase women had more active phase arrest (odds ratio [OR] 2.2), oxytocin use (OR 2.3), scalp pH performed (OR 2.2), intrauterine pressure catheter placed (OR=2.2), fetal scalp electrocardiogram monitoring (OR=1.7), and amnionitis (OR 2.7) (*P*<.001 for each).
Lavender 2005	England	Observational, longitudinal	Multiparous women, in the first stage of labor with uncomplicated pregnancies	Vaginal examinations every 2 hours	n/a	403 women	Cervical dilation	Moderate risk of bias	The median rate of dilatation was 1.9 cm/hour and the 5th percentile was 0.5 cm/hour. There was a weak positive correlation between initial dilatation and rate of dilatation (r=0.2).
Simon 2005	United States	Analysis	Nulliparous women undergoing labor induction with a pregnancy of 36 weeks or more of gestation	Induction protocol	n/a	397 women	Length of latent phase, maternal and neonatal outcomes, maternal and neonatal morbidity	Serious risk of bias	Only 8 women (2%) never achieved active phase labor before cesarean, and the overall cesarean rate was 26.0%. A longer latent phase was associated with a greater rate of cesarean delivery, although only after 18 hours did a majority of induced labors result in cesarean. Chorioamnionitis and postpartum hemorrhage were more frequent with latent phases of labor greater than 18 hours (16% and 26%, respectively), although these diagnoses did not translate into greater risk of transfusion, hysterectomy, or prolonged hospitalization. Neonatal outcomes, including meconium passage, fetal acidemia, neonatal intensive care unit admission, or other morbidity did not increase in conjunction with longer latent phases.
Vahratian 2005	United States	Retrospective analysis	Low-risk, nulliparous women	Elective induction of labor (subdivided into 2 subgroups: 1) preinduction cervical ripening followed by oxytocin induction and 2) oxytocin induction without preinduction cervical ripening; "Postdates" inductions before 41 weeks	Spontaneous onset of labor	2,200 women	Labor progression, risk of cesarean delivery	Moderate risk of bias	Electively induced labor with cervical ripening had substantially slower latent and early active phases. After controlling for potential confounders, women who had an elective induction with cervical ripening had 3.5 times the risk of cesarean delivery during the first stage of labor (95% CI 2.7–4.5), compared with those admitted in spontaneous labor. Elective induction without cervical ripening, on the other hand, was associated with a faster labor progression from 4–10 cm (266 compared with 358 minutes, *P*<.01) and did not increase the risk of cesarean delivery, compared with those in spontaneous labor.
Zaretsky 2005	United States	Prospective	Nulliparous women scheduled for a labor	Magnetic resonance imaging (MRI)	Magnetic resonance imaging (MRI)	101 women	Labor dystocia, maternal pelvic	Moderate risk of bias	No single fetal measurement was statistically associated with dystocia. Several maternal pelvic measures, fetal-to-maternal ratios, and previously reported

			induction for prolonged pregnancy (42 weeks)	pelvimetry; results from women undergoing operative vaginal delivery for labor dystocia	pelvimetry; results from women not undergoing operative vaginal delivery for labor dystocia		measures, fetal-to-maternal ratios		pelvimetric techniques were significantly associated with dystocia. The ratio of magnetic resonance (MR) fetal head volume to pelvic soft tissue volume had statistical significance (*P*=.04). Receiver operator characteristic curves were developed for the different measurements, ratios, and formulas studied to assess whether any of the techniques could accurately predict labor dystocia requiring operative delivery. The area under the curve values ranged from 0.6 to 0.8, with the ratio of MR head volume to pelvic soft tissue being 0.7. These values suggest that MRI can identify those women at greatest risk for dystocia, but it cannot with accuracy predict which ones will require a cesarean.
Cheng 2004	United States	Retrospective cohort	Nulliparous, term, cephalic, live singleton births to nulliparous patients	Second stage of labor was subdivided into 1-hour intervals: hours 0–1, 1–2, 2–3, 3–4, and more than 4	Comparisons between intervals	15,759 births	Postpartum hemorrhage, chorioamnionitis, endomyometritis, perineal trauma, operative vaginal delivery, cesarean delivery, presence of meconium-stained amniotic fluid, umbilical artery pH, 5-minute Apgar score >7, incidences of shoulder dystocia, rates of admission to the intensive care nursery	Moderate risk of bias	Increasing rates of cesarean delivery, operative vaginal delivery, and perineal trauma were associated with the second stage beyond the first hour. In multivariate analysis, the >4-hour interval group had higher rates of cesarean delivery (odds ratio, 5.65; *P*<.001), operative vaginal deliveries (odds ratio, 2.83; *P*<.001), 3rd- or 4th-degree perineal lacerations (odds ratio, 1.33; *P*=.009), and chorioamnionitis (odds ratio, 1.79; *P*<.001). There were no differences in neonatal acid-base status associated with length of second stage. However, there were fewer neonates with a 5-minute Apgar score of less than 7 (odds ratio, 0.45; *P*=.01).
Rouse 2004	United States	Prospective observational	Women at term carrying a singleton gestation who underwent primary cesarean	Diagnosed chorioamnionitis	No diagnosed chorioamnionitis	16,650 pregnancies (1,965 with chorioamnionitis)	Maternal and fetal-neonatal adverse outcomes	Serious risk of bias	16,650 pregnancies were analyzed, 1,965 (12%) with chorioamnionitis, which was associated with significantly increased risks of maternal blood transfusion, uterine atony, septic pelvic thrombophlebitis, and pelvic abscess (RR 2.3–3.7), as well as 5-minute Apgar $\leq$ 3, neonatal sepsis, and seizures (RR 2.1–2.8). By test of trend, only uterine atony (*P*<.01), maternal blood transfusion (*P*=.03), maternal admission to intensive care unit (*P*=.02), and 5-minute Apgar $\leq$ 3 (*P*<.01) were associated with duration of chorioamnionitis. By logistic analysis, only uterine atony (OR for each hour of chorioamnionitis 1.03, 95% CI 1.00–1.06), 5-minute Apgar $\leq$ 3 (OR 1.09, 95% CI 1.00–1.16), and neonatal mechanical ventilation within 24 hours of birth (OR 1.07, 95% CI 1.01–1.12) were significantly associated with chorioamnionitis duration.

Bohra 2003	Ireland	Prospective observational	Primigravida who presented in spontaneous labor at term and with cephalic presentation	Active management of labor (early amniotomy, 2-hourly vaginal examinations, oxytocin augmentation where progress of labor was slow and the presence of a companion (personal nurse) in labor))	n/a	1,000 women	Mode of delivery, duration of labour, analgesia usage and maternal perinatal complications	Serious risk of bias	All patients presented with painful uterine contractions, 75% with show in addition, and 36% had spontaneous rupture of membranes on admission. Eighty per cent presented with a cervical dilatation of 2 cm or less; 72.2% had epidural for pain relief. In 81.8% of cases electronic fetal monitoring was used to monitor the baby. Oxytocin was used in 51.8% to augment labor and a further 6.4% required its use for the first time in the second stage of labor. Fetal blood sampling was performed in 20.8%. The spontaneous vaginal delivery rate was 71.8%, 4.2% were delivered by cesarean section and the operative vaginal delivery rate was 24%. The incidence of prolonged labour (labor duration greater than 12 hours) was 4.3%. Postpartum hemorrhage occurred in 3.8% of mothers and 1.6% of babies were admitted to the special care baby unit.
Alexander 2002	United States	Secondary analysis of RCT	Singleton, cephalic, nonanomalous fetus at or beyond 37 weeks' gestation (limited to women who had cervical dilatation commencing of at least 3 cm (ie, active phase of labor))	Patient controlled epidural analgesia	Patient-controlled intravenous meperidine analgesia	459 women	Labor curves, labor complications, delivery method	Moderate risk of bias	Twenty-five women were excluded for a cervix less than 3 cm dilated, leaving 220 women allocated to patient-controlled epidural analgesia and 214 to patient-controlled intravenous meperidine available for analysis. There were no significant demographic differences between the two groups, including age, race, gestational age, and cervix on admission. The active phase of labor was 1 hour longer in the epidural-treated group (6.0 $\pm$ 3.2 hours versus 5.0 $\pm$ 3.2 hours, P<.001). The rate of cervical dilation was significantly less with epidural analgesia (1.4 cm/h versus 1.6 cm/h, P<.002). The duration of the second stage tended to be longer in the epidural group (1.1 $\pm$ 1.5 hours versus 0.9 $\pm$ 1.0 hours, P=.079).
Zhang 2002	United States	Analysis from previous study data	Nulliparous parturients with a term, singleton, vertex fetus of normal birth weight after spontaneous onset of labor	Labor and delivery services	n/a	1,329 subjects	Labor progression	Moderate risk of bias	Our average labor curve differs markedly from the Friedman curve. The cervix dilated substantially slower in the active phase. It took approximately 5.5 hours from 4 cm to 10 cm, compared with 2.5 hours under the Friedman curve. We observed no deceleration phase. Before 7 cm, no perceivable change in cervical dilation for more than 2 hours was not uncommon. The 5th percentiles of rate of cervical dilation were all below 1 cm per hour. The 95th percentile of time interval for fetal descent from station +1/3 to +2/3 was 3 hours at the second stage.
Miles 2001	United States	Prospective observational	Women with singleton gestation at 36–41 weeks' in	Intrauterine pressure	External tocodynamometry (ET)	20 patients	Amplitude, duration, and	Moderate risk of bias	Uterine contractions were recorded simultaneously by ET and IUPC for 2 hours. ET and IUPC data were compared using the Spearman correlation coefficient and the Wilcoxon signed-rank test. The median body

			active phase labor, defined as cervical dilation 4 cm or more	monitoring (IUPC)			frequency of uterine contractile activity		mass index (BMI) of the patient population was 31.8 kg/m2 (range 22.2 to 42.3). There was good correlation of contraction frequency measured by ET and IUPC (r = 0.75, *P*=.001), but poor correlation of both contraction amplitude (r=0.26) and duration (r=0.27).
Sizer 2000	United Kingdom	Prospective observational	Women at term with a singleton, cephalic presentation	Second stage partogram	Compared at different time points	1,413 women	Define normal and abnormal progress in the second stage, associated factors in the first stage of labor, mode of delivery	Serious risk of bias	Increasing total score at the start of the second stage of labor is associated with increasing chance of spontaneous vaginal delivery (odds ratio [OR] 1.68 for nulliparas, 1.59 for multiparas), decreasing chance of instrumental vaginal delivery (OR 0.67 for nulliparas, 0.64 for multiparas), and emergency cesarean delivery (OR 0.39 for nulliparas). Abnormal progress as defined by the normogram is associated with use of epidural anesthesia, induction of labor, augmentation, dystocia, and increased incidence of operative delivery. No significant difference is found between normal and abnormal second stages of labor in fetal outcome as determined by Apgar scores.
Rouse 2000	United States	Retrospective	Gravidas at or beyond 36 weeks' gestation undergoing indicated induction with cervical dilatation up to 2 cm	Protocol that mandated at least 12 hours of oxytocin administration after membrane rupture before cesarean delivery for failed labor induction in the latent phase	n/a	509 women	Safety and efficacy of protocol	Serious risk of bias	360 (71%) were nulliparas and 149 (29%) were parous. Twenty-five percent of nulliparas and 9% of parous women were delivered by cesarean. After 6 hours of ruptured membranes and oxytocin, 14% of nulliparas were still in the latent phase; 39% of whom delivered vaginally, compared with 7% still in the latent phase after 9 hours (vaginal delivery rate 28%), and 4% after 12 hours (vaginal delivery rate 13%). In contrast, after 6 hours of ruptured membranes and oxytocin, only five (3%) parous women were still in the latent phase. Among those, none remained in the latent phase for 12 hours and all were delivered vaginally. No women had serious complications. Severe neonatal morbidities were infrequent and not related to duration of the latent phase.
Rhoades 2017	Global	Literature review	Women in first stage of labor	Normal first stage of labor	Abnormal first stage of labor	n/a	Definitions, labor management	n/a	The first stage of labor has a significantly longer latent phase than was previously thought, especially in nulliparous patients, obese patients, and induction of labor. The transition from the latent phase to the active phase of labor does not occur until 6 cm of cervical dilatation in all patients. Arrest of the first stage of labor is diagnosed by greater than or equal to 6 cm of dilatation, ruptured membranes, and no cervical change with 4 hours of adequate or 6 hours of inadequate contractions. Failed induction of labor is diagnosed after cervical ripening by failure to generate regular contractions and cervical change with 24 hours of oxytocin and rupture of membranes. Providers should be aware of abnormal progression in the first stage of labor and use oxytocin, internal tocodynamometry, and/or amniotomy to increase the likelihood of vaginal delivery.

Cohen 2015	United States	Expert review	Laboring women	Descriptions of normal and abnormal labor progress	n/a	n/a	n/a	n/a	Authors contend that the original descriptions of normal and abnormal labor progress, which were based on direct clinical observations, accurately describe progress in dilatation and descent, and that the differences reported more recently are likely attributable to patient selection and the potential inaccuracy of very high-order polynomial curve-fitting methods. The clinical evaluation of labor is a process of serially estimating the likelihood of a safe vaginal delivery. Because many factors contribute to that likelihood, such as cranial molding, head position and attitude, and the bony architecture and capacity of the pelvis, graphic labor patterns should never be used in isolation. The new guidelines are based heavily on unvalidated notions of labor progress and ignore clinical parameters that should remain cornerstones of intrapartum decision-making.
Tilden 2015	United States	Cost-effectiveness model	Term, medically low-risk women	Admitted in latent labor (< 4 cm dilation)	Delaying admission until active labor (≥ 4 cm dilation)	3.2 million women	Epidural use, mode of delivery, stillbirth, maternal death, costs of care	n/a	Delaying admission until active labor would result in 672,000 fewer epidurals, 67,232 fewer cesarean deliveries, and 9.6 fewer maternal deaths in our theoretic cohort as compared to admission during latent labor. Additionally, delaying admission results in a cost savings of $694 million annually in the United States. Sensitivity analyses indicated the model was robust within a wide range of probabilities and costs. Monte Carlo simulation found that delayed admission was the optimal strategy in 76.79 percent of trials.
Spong 2012	Global	Literature review	Laboring women	Labor management	n/a	n/a	Factors contributing to the primary cesarean rate	n/a	Key points were identified to assist with reduction in cesarean rates including that labor induction should be performed primarily for medical indication; if done for non-medical indications, the gestational age should be at least 39 weeks or more and the cervix should be favorable, especially in the nulliparous patient. Review of the current literature demonstrates the importance of adhering to appropriate definitions for failed induction and arrest of labor progress. The diagnosis of “failed induction” should only be made after an adequate attempt. Adequate time for normal latent and active phases of the first stage, and for the second stage, should be allowed, as long as the maternal and fetal conditions permit. The adequate time for each of these stages appears to be longer than traditionally estimated. Operative vaginal delivery is an acceptable birth method when indicated and can safely prevent cesarean delivery. Given the progressively declining use, it is critical that training and experience in operative vaginal delivery is facilitated and encouraged. When discussing the first cesarean with a patient, counseling should include its effect on future reproductive health.
Zhang 2015	United States	Expert review	Laboring women	Labor curve	n/a	n/a	n/a	n/a	Important to provide clarification of the modern statistical analysis of labor progression on 3 aspects: 1.

									Differences in philosophy and approach to construct a labor curve 2. Idealized vs average labor curves 3. Effects of cesarean deliveries in the first stage of labor on the labor curve.
Wilmink 2008	Global and Netherlands	Literature review and case reports	Cases with placement of an intrauterine pressure monitoring (IUPC) during induction of labor with oxytocin	IUPC	n/a	2 cases	Maternal and perinatal outcomes, fetal complications	n/a	One presenting with a singleton pregnancy and the other a twin pregnancy. After introduction of the IUPC, both cases were complicated by blood loss and signs of fetal distress on cardiotocography. An emergency cesarean section was performed in both cases. In the first case, extramembranous placement of the IUPC was observed, whereas in the second case, the IUPC had lacerated an arteriovenous anastomosis in the membranes, resulting in perinatal death.

Management of Dystocia in the First Stage of Labor

Author, Year	*Setting*	*Design/ approach*	*Subjects*	*Intervention*	*Comparator*	*Sample size*	*Outcomes*	*Quality Assessment*	*Results*
CO 766: Approaches to Limit Intervention During Birth and Labor	United States	Guideline	Women during labor and birth	Approaches to limit intervention	n/a	Systematic review/ meta-analyses, RCTs, observational studies, literature reviews	Labor outcomes	5.02 out of 7	Admission to labor and delivery may be delayed for women in the latent phase of labor when their status and their fetuses' status are reassuring. The women can be offered frequent contact and support, as well as nonpharmacologic pain management measures. When women are observed or admitted for pain or fatigue in latent labor, techniques such as education and support, oral hydration, positions of comfort, and nonpharmacologic pain management techniques such as massage or water immersion may be beneficial. For women with normally progressing labor and no evidence of fetal compromise, routine amniotomy need not be undertaken unless required to facilitate monitoring. Frequent position changes during labor to enhance maternal comfort and promote optimal fetal positioning can be supported as long as adopted positions allow appropriate maternal and fetal monitoring and treatments and are not contraindicated by maternal medical or obstetric complications. When not coached to breathe in a specific way, women push with an open glottis. In consideration of the limited data regarding superiority of spontaneous versus Valsalva pushing, each woman should be encouraged to use her preferred and most effective technique. Collectively, and particularly in light of recent high quality study findings, data support pushing at the start of the second stage of labor for nulliparous women receiving neuraxial analgesia. Delayed pushing has not been shown to significantly improve the likelihood of vaginal birth and risks of delayed pushing, including infection, hemorrhage,

									and neonatal acidemia, should be shared with nulliparous women receiving neuraxial analgesia who consider such an approach.
Choi 2016	South Korea	Prospective cohort	Singleton primiparous pregnancies of 37–42 completed gestational weeks without known fetal abnormalities	Transabdominal assessment and epidural anesthesia under active management protocol (occiput posterior position group)	Transabdominal assessment and epidural anesthesia under active management protocol (non-OP position group)	162 women	Postpartum hemorrhage, infection and fourth-degree perineal laceration, grade-III meconiumstained amniotic fluid (clinically defined thick meconium), low Apgar score (1- or 5-min Apgar score) and neonatal intensive care unit (NICU) admission	Moderate risk of bias	Fifty-six of 162 fetuses were found to be in the OP position during the first stage of labor. Eight (80.0%) of 10 fetuses in the OP position during the second stage were among the 56 that were in OP position during the first stage. The rate of cesarean sections performed in the OP position group during the first stage was significantly higher than the rate in the non-OP position group (37.5% versus 8.5%, *P*<.0001). The duration of the second stage of labor was longer and neonatal complications occurred more frequently in the OP position group during the second stage than in the non-OP position group (77.9 ± 33.4 min versus 52.2 ± 26.6 min, *P*=.0104; 50.0% versus 17.2%, *P*=.0118).
Lee 2012	South Korea	Retrospective cohort	Term singleton nulliparas whose labor was induced	‘‘early ROM’’, defined as ROM at a cervical dilatation less than 4 cm during labor	‘‘late ROM’’, ROM at a cervical dilatation 4 cm or later during labor	500 cases	Gestational age at delivery, birthweight, macrosomia, cesarean section, operative vaginal delivery, acute histologic chorioamnionitis, funisitis, Apgar score	Moderate risk of bias	‘‘early ROM’’ occurred in 43% and the overall cesarean section rate was 15.8%; patients with ‘‘early ROM’’ had a higher rate of cesarean section and cesarean section due to failure to progress than did those with ‘‘late ROM’’ (overall cesarean section rate: 24% [51/215] vs. 10% [28/285], *P*<.01; cesarean section rate due to failure to progress: 18% [38/215] vs. 8% [22/285], *P*<.01 for each) and this difference remained significant after adjusting for confounding variables.
Amniotomy									
De Vivo 2020	Global	Systematic review and meta-analysis	Pregnant women at term with singleton gestation and cephalic presentation who were admitted for induction of labor because of	Early amniotomy after cervical ripening with either Foley catheter or prostaglandins at any dose	Control (ie, late amniotomy or spontaneous rupture of membranes) after cervical ripening with either Foley catheter or	4 trials (1,273 women)	Incidence of cesarean delivery	High quality review	Women who were assigned randomly to early amniotomy had a similar risk of cesarean delivery (31.1% vs 30.9%; relative risk, 1.05; 95% confidence interval, 0.71–1.56) compared with control subjects and had a shorter interval from induction to delivery of approximately 5 hours (mean difference, -4.95 hours; 95% confidence interval, -8.12 to -1.78). Spontaneous vaginal delivery was also reduced in the early amniotomy group, but only 1 of the included trials reported this outcome (67.5% vs 69.1%; relative risk, 0.78; 95% confidence interval,

			different conditions		prostaglandins at any dose				0.66–0.93). No between-group differences were reported in the other obstetrics or perinatal outcomes.
Myers 2020 (Labor Dystocia AHRQ report)	Global	Systematic review	Women aged 15-44 with uncomplicated pregnancy at 37–42 weeks gestation with a singleton pregnancy with vertex presentation	Routine amniotomy (artificial rupture of membranes)	No amniotomy, amniotomy for specific indications (eg, placement of fetal scalp monitor or intrauterine pressure catheter)	9 RCTs, 3 SRs/MAs	Adverse maternal effects, adverse neonatal effects, labor progress	High quality review	Amniotomy decreases the total duration of labor in nulliparous women (moderate strength of evidence (SOE)) and those with unspecified parity (low SOE). There was no difference in the rate of cesarean delivery for early amniotomy versus control in women with unspecified parity (moderate SOE). There were no differences in rates of maternal infection, hemorrhage, or trauma to the pelvic floor (moderate SOE) for early amniotomy versus control. Routine amniotomy plus oxytocin decreases the duration of labor and has a similar effect in both nulliparous and parous women (high SOE). Routine amniotomy plus oxytocin does not differ compared with control treatment in cesarean delivery rates in both nulliparous and parous women (high SOE).
Smyth 2013	Global	Systematic review and meta-analysis	Pregnant women with singleton pregnancies regardless of parity and gestation at trial entry in spontaneous labor	Amniotomy	Intention to preserve the membranes (no amniotomy)	15 studies (5,583 women)	Length of first stage of labor (minutes), cesarean section, maternal satisfaction with childbirth experience, low Apgar score, maternal adverse effects, fetal adverse effects, duration of hospital stay, cost of hospital stay	High quality review	There was no clear statistically significant difference between women in the amniotomy and control groups in length of the first stage of labor (mean difference (MD) -20.43 minutes, 95% CI -95.93 to -55.06), caesarean section (risk ratio (RR) 1.27, 95% CI 0.99–1.63), maternal satisfaction with childbirth experience (MD -1.10, 95% CI -7.15 to 4.95) or Apgar score less than seven at five minutes (RR 0.53, 95% CI 0.28–1.00). There was no consistency between trials regarding the timing of amniotomy during labor in terms of cervical dilatation. There was no clear statistically significant difference between women in the amniotomy and control group in caesarean section (RR 0.95, 95% CI 0.15–6.08), maternal satisfaction with childbirth experience (MD 22.00, 95% CI 2.74–41.26) or Apgar score less than seven at five minutes (RR 2.86, 95% CI 0.12–66.11).
Howarth 2001	Global	Systematic review and meta-analysis	Women due for third trimester induction of labor, with a viable fetus	Amniotomy plus oxytocin	Placebo/no treatment or other methods of induction of labor	17 trials (2,566 women)	Vaginal delivery not achieved within 24 hours, uterine hyperstimulation with fetal heart rate (FHR) changes, caesarean section, serious neonatal morbidity or	High quality review	Amniotomy and intravenous oxytocin were found to result in fewer women being undelivered vaginally at 24 hours than amniotomy alone (relative risk (RR) 0.03, 95% CI 0.001–0.49). This finding was based on the results of a single study of 100 women. As regards secondary results amniotomy and intravenous oxytocin resulted in significantly fewer instrumental vaginal deliveries than placebo (RR 0.18, CI 0.05–0.58). Amniotomy and intravenous oxytocin resulted in more postpartum hemorrhage than vaginal prostaglandins (RR 5.5, CI 1.26–24.07). Significantly more women were also dissatisfied with amniotomy and intravenous oxytocin when compared with vaginal prostaglandins, RR 53, CI 3.32–846.51.

							perinatal death, serious maternal morbidity or death, maternal adverse effects, satisfaction		
Bricker 2000	Global	Systematic review	Pregnant women due for third trimester induction of labor, carrying a live fetus	Amniotomy alone	Placebo/no treatment or any other method of labor induction	2 trials (310 women)	Vaginal delivery not achieved within 24 hours, uterine hyperstimulation with fetal heart rate (FHR) changes, caesarean section, serious neonatal morbidity or perinatal death, serious maternal morbidity or death, maternal adverse effects, satisfaction	High quality review	No conclusions could be drawn from comparisons of amniotomy alone versus no intervention, and amniotomy alone versus oxytocin alone (small trial, only one pre-specified outcome reported). No trials compared amniotomy alone with intracervical prostaglandins. One trial compared amniotomy alone with a single dose of vaginal prostaglandins for women with a favorable cervix and found a significant increase in the need for oxytocin augmentation in the amniotomy alone group (44% versus 15%; relative risk 2.85, 95% confidence interval 1.82–4.46). This should be viewed with caution as this was the result of a single-center trial. Furthermore, secondary intervention occurred four hours after amniotomy, and this time interval may not have been appropriate.
Titulaer 2019	Netherlands	Randomized controlled trial	Women with term, singleton pregnancy in vertex position undergoing labour induction	Amniotomy with 12-hours delayed oxytocin (DO)	Amniotomy with immediate oxytocin (IO)	64 women	Amniotomy-to-delivery interval and patient reported experience	High risk of bias	The median amniotomy-to-delivery interval for the DO-group was 15 h (IQR 8–21), and 6 h (IQR 5–11) for the IO-group (HR, 0.41; 95% CI, 0.24–0.70), with equal patient reported childbirth perception in the overall group (*P*=.43). Parous women reported a significantly less positive perception of labor (*P*=.02) and used pain relief more often (RR, 2.93; 95% CI, 1.05–8.19) in the DO-group. The proportion of women delivered within 24 h was not significantly different between groups (RR, 0.30; 95% CI, 0.05–1.83). Other delivery and neonatal outcomes did not differ significantly between groups, possibly due to being underpowered.
Bostanci 2018	Turkey	Randomized controlled trial	Term pregnant women	Early amniotomy (artificial rupture of membranes when cervical	Standard amniotomy (the membranes were left to rupture	200 women	Time from induction to delivery, and the proportion of women who delivered	High risk of bias	The median time interval from induction to delivery (13.72 hours compared to 22.73 hours) was significantly shorter for women who underwent early amniotomy (*P*<.05). The frequency of vaginal delivery within 24 hours was higher in women with early amniotomy (89% compared with 45% in the standard amniotomy, *P*<.05).

				dilation was at 3 cm)	spontaneously)		within 24 hours		
Gagnon-Gervais 2012	Canada	Randomized controlled trial	Women admitted for induction	Early amniotomy	Late amniotomy	143 women	Rate of cesarean, duration of labor, intrapartum fever	High risk of bias	The cesarean rate was similar between groups (18% vs. 17% among nulliparous; and 3% vs. 0% among parous women, in EA and LA group, respectively). However, EA was associated with shorter oxytocin-to-delivery interval (12 vs. 15 hours) and a non-significant decrease in intrapartum fever (3% vs. 25%) than LA in nulliparous women (*P*=.05).
Macones 2012	United States	Randomized controlled trial	Nulliparous patients with singleton, term gestation, and a need for labor induction	Early amniotomy	Standard management	585 patients	Time from induction initiation to delivery, proportion of women who delivered within 24 hours	Low risk of bias	Early amniotomy shortens the time to delivery by more than 2 hours (19.0 vs 21.3 hours) and increases the proportion of induced nulliparous women who deliver within 24 hours (68% vs 56%). These improvements in labor outcomes did not come at the expense of increased complications.
Nachum 2010	Israel	Randomized controlled trial	Women with a singleton fetus in cephalic presentation who have a prolonged latent phase	Amniotomy; oxytocin; both amniotomy and oxytocin	Spontaneous progression	283 women	Duration of time from initiation of augmentation until delivery	Low risk of bias	A mean reduction of 120 minutes in labor duration was observed among group 3 compared to group 1 (*P*=.08) and 180 minutes compared to group 2 and 4 (*P*=.001). Women in group 3 had a shorter length of time from augmentation until the beginning of the active phase and a shorter first stage of labor than group 1 (*P*=0.03), group 2 (*P*=.001) and group 4 (*P*=.001). Satisfaction was greater among group 3 and 4. Mode of delivery and neonatal outcome were comparable between the groups.
Selo-Ojeme 2009	United Kingdom	Randomized controlled trial	Nulliparous women with singleton term pregnancy in cephalic presentation and with intact membranes, no regular uterine contractions, a favourable cervix, no significant foetal or maternal medical conditions and no previous uterine surgery	Amniotomy and immediate oxytocin infusion	Amniotomy and delayed oxytocin infusion	123 women	Proportion of women in established labour at 4 h, proportion that delivered within 12 h of amniotomy	High risk of bias	Women in the immediate group were more likely to be in established labor 4 hours post-amniotomy [relative risk (RR) 12.8; 95% CI 55.1–111.7], have a shorter amniotomy to delivery interval (*P*<.001) and achieve vaginal delivery within 12 h (RR 1.5; 95% CI 1.2–12.6). There was no difference between the groups with regards to the mode of delivery, incidence of uterine hyperstimulation and abnormal fetal heart rate recording. Compared to the delayed group, women in the immediate group were more likely to be satisfied with the induction process (RR 4.1, 95% CI 1.1–16.1) and the duration of labour (RR 1.8 95% CI 1.0–3.3).

Levy 2002	Israel	Randomized controlled trial	Pregnant women ≥ 38 weeks of a singleton gestation, who had had no prior caesarean section	Early amniotomy	Late amniotomy	168 women	Mode of delivery, duration of labour	Unclear/low risk of bias	The rate of caesarean section was significantly higher in the early amniotomy group compared with the late amniotomy group (25% vs 7.9%; relative risk 1.74; 95% CI 1.3–2.34). The increase in caesarean section rate was due primarily to dystocia (15% vs 3.3%; relative risk 1.8; 95% CI 1.32–2.45). When excluding caesarean deliveries, no significant difference was found in duration of labor between the groups (8.3 hours (3.8) vs 7.7 hours (2.9)).
Ganer Herman 2018	Israel	Retrospective cohort	Patients who presented in spontaneous labor at term where AROM was performed during the active stage of labor	Deliveries who developed nonreassuring FHR	Deliveries with a normal FHR	644 deliveries	Adverse neonatal composite outcome, time from AROM to delivery, meconium, oxytocin augmentation	Moderate risk of bias	Nonreassuring FHR occurred in 141 (21.2%) and normal FHR in 523 (78.7%). Both groups were notable for similar maternal characteristics and a similar gestational age. Epidural block was significantly more common in the nonreassuring FHR group (*P*<.001), as was meconium during delivery (*P*=.01). Deliveries in the nonreassuring FHR group were characterized by significantly lower Bishop scores at AROM. Mean birthweight was significantly lower in the nonreassuring FHR group (3201 ± 418 vs 3342 ± 376 g, *P*<.001), yet, neonatal outcome did not differ between the groups. In a multivariate logistic regression model, nulliparity, AROM at a station lower than -2, and increased birthweight were all significantly associated with a decreased rate of nonreassuring FHR, while prolonged duration from AROM to delivery and oxytocin augmentation significantly increased the risk for nonreassuring FHR.
Grobman AJOG 2018	United States	Retrospective cohort	Nulliparous women who had a term singleton gestation in the cephalic presentation	Induction of labor	Duration of latent phase	10,677 women	Rates of cesarian deliveries, adverse maternal/perinatal outcomes	Moderate risk of bias	The large majority of women undergoing labor induction will have entered the active phase by 15 hours after oxytocin has started and rupture of membranes has occurred. Maternal adverse outcomes become statistically more frequent with greater time in the latent phase, although the absolute increase in frequency is relatively small. These data suggest that cesarean delivery should not be undertaken during the latent phase prior to at least 15 hours after oxytocin and rupture of membranes have occurred.
Battarbee 2016	United States	Retrospective matched cohort	Nulliparous women with a singleton viable gestation undergoing cervical ripening with a Foley balloon catheter	Early amniotomy (defined as artificial rupture of membranes less than 1 hour after Foley removal)	No artificial rupture of membranes in the first hour	546 women	Vaginal delivery within 24 hours of the beginning of labor induction, obstetric outcomes, neonatal outcomes	Moderate risk of bias	In univariable analysis, the frequency of vaginal delivery within 24 hours of Foley placement was higher in women with early amniotomy (42.9% compared with 33.0%, *P*=.02). The median time intervals from Foley catheter removal to complete dilation (9.0 hours compared with 12.1 hours) and to delivery (10.6 hours compared with 13.8 hours) were also significantly shorter for women who underwent early amniotomy (*P*<.001 for both). There were no significant differences in any other adverse maternal or neonatal outcomes. In multivariable analysis, early amniotomy remained associated with higher odds of vaginal delivery within 24 hours and shorter times from catheter removal to complete dilation and to delivery.

Gross 2014	Germany	Longitudinal cohort	Nulliparae and multiparae with a singleton in cephalic presentation	Administration of amniotomy, oxytocin initiation or neuraxial analgesia	n/a	3,963 women	Labor duration, complete dilatation, spontaneous or operative vaginal delivery or cesarean delivery, adverse maternal and fetal outcomes	Moderate risk of bias	From amniotomy onwards labor was accelerated. In multiparae, amniotomy was associated with an initial 6.6-fold acceleration, decreasing first stage duration until the hazard ratio reached around 3.5, where the intervention was performed 5 hours after labor onset; thereafter, acceleration continued with a hazard ratio of around 3. In nulliparae, neuraxial analgesia was associated with a shorter first stage when administered between 7 and 11 hours after labor onset; the later it was performed, the less likely was spontaneous birth and the more likely an operative vaginal birth in nulliparae or a cesarean section in multiparae. The start of oxytocin augmentation was associated with acceleration towards both full dilatation and caesarean section during first stage and an increased risk of operative vaginal birth during second stage. The later oxytocin augmentation started, the more likely it was that spontaneous birth would be retarded in multiparous women.
Cooley 2010	Ireland	Retrospective descriptive	Women who required induction of labor	Amniotomy alone for induction of labor	Prostaglandin priming of the cervix prior to amniotomy or spontaneous onset of labor	4,928 women	Mode of delivery	Moderate risk of bias	In total, 26,670 women delivered in the National Maternity Hospital during the study period. Of these 4,928 women required induction of labor and 72.8% of these (n=3,586) underwent amniotomy only for induction of labour. Spontaneous labor occurred in 90.1% of the women who underwent amniotomy within 24 hours. Oxytocin as an induction agent was employed in 9.8% of cases. Overall, 80.5% of the women had a spontaneous delivery, 7.3% had a ventouse delivery, 4.3% had a forceps delivery, and 7.9% underwent a cesarean section. In total, 90.5% of multips and 63.4% of primips had a spontaneous vaginal delivery.
Sheiner 2000	Israel	Prospective	Parturients with Bishop scores of less than 5, singleton gestations, vertex presentation, term delivery	Early amniotomy	PROM or induction by oxytocin	272 parturients	Indication for cesarean delivery, labor duration, mode of delivery, Apgar scores and birth weight	Moderate risk of bias	The duration of the first stage of labor was significantly longer in the PROM group (987.8 ± 572.3 min) as compared with the early amniotomy group (615.0 ± 389.6 min) and the oxytocin induction group (650.9 ± 349.5 min, *P*<0.001). Higher rates of CS were found in the study group (26.7%) as compared to the controls (11.6% in the PROM and 16.9% in the oxytocin groups, *P*=.012). Neonatal outcome was similar in all groups. A stratified analysis comparing the risk of cesarean section while controlling for a previous one did not show a significant difference between the early amniotomy and the oxytocin administration groups.
Oxytocin									
Myers 2020 (Labor Dystocia AHRQ report)	Global	Systematic review	Women aged 15-44 with uncomplicated pregnancy at 37–42 weeks with a	Infusion of low-dose oxytocin	High-dose oxytocin; nipple stimulation; maternal oxygen	12 articles	Adverse maternal effects, adverse neonatal effects, labor progress	High quality review	In nulliparous women, high-dose oxytocin is associated with a lower cesarean delivery rate (moderate SOE) compared with low-dose oxytocin protocols with no difference in maternal hemorrhage (low SOE). Early administration of oxytocin is associated with a shorter duration of labor (moderate SOE) but does not affect the overall cesarean delivery rate compared

			diagnosed abnormality of the first stage of labor		supplementation as an adjunct to oxytocin; different formulations of oxytocin				with delayed administration (moderate SOE). There is no difference in adverse events of maternal outcomes of hemorrhage or transfusion (low SOE) or in mode of delivery (low SOE). Pulsatile administration of oxytocin is associated with a longer duration of labor compared with continuous administration (low SOE). There is no difference in cesarean delivery rate between women managed with oxytocin compared to expectant management (moderate SOE).
Boie 2018	Global	Systematic review and meta-analysis	Women undergoing induction of labor	Discontinuation of oxytocin infusion	Continuation of oxytocin infusion	10 RCTs (1,888 women)	Cesarian delivery rate	Moderate quality review	Discontinuing IV oxytocin stimulation after the active phase of labour has been established may reduce caesarean delivery but the evidence for this was low certainty. When restricting our analysis to those trials that separately reported participants who reached the active phase of labour, our results showed there is probably little or no difference between groups. Discontinuing IV oxytocin may reduce uterine tachysystole combined with abnormal FHR.
Saccone 2017	Global	Systematic review and meta-analysis	Women undergoing induction of labor	Discontinuation of oxytocin infusion	Continuation of oxytocin infusion	9 RCTs (1,538 women)	Incidence of cesarean delivery, mean duration of the active phase, and of the second stage of labor, incidence of vaginal delivery, operative vaginal delivery, indications for cesarean delivery, epidural analgesia, uterine tachysystole, postpartum hemorrhage, chorioamnionitis, abnormal fetal heart rate, and neonatal outcomes, including birth weight, admission to the neonatal intensive care unit,	Moderate quality review	In the discontinuation group, if arrest of labor occurred, usually defined as no cervical dilation in 2 hours or inadequate uterine contractions for 2 hours or more, oxytocin infusion was restarted. Women in the control group had oxytocin continued until delivery usually at the same dose used at the time the active phase was reached. Women who were randomized to have discontinuation of oxytocin infusion after the active phase of labor was reached had a significantly lower risk of cesarean delivery (9.3% compared with 14.7%; relative risk 0.64, 95% CI 0.48–0.87) and of uterine tachysystole (6.2% compared with 13.1%; relative risk 0.53, 95% CI 0.33–0.84) compared with those who were randomized to have continuation of oxytocin infusion until delivery. Discontinuation of oxytocin infusion was associated with an increase in the duration of the active phase of labor (mean difference 27.65 minutes, 95% CI 3.94–51.36).

							and Apgar score		
Budden 2014	Global	Systematic review and meta-analysis	Pregnant women for induction of labor carrying a viable fetus from 37 weeks of completed gestation	High-dose regimen	Low-dose regimen	9 trials (2,391 women)	Vaginal delivery not achieved within 24 hours, uterine hyperstimulation with fetal heart rate (FHR) changes, caesarean section, serious neonatal morbidity or perinatal death, serious maternal morbidity or death, maternal adverse effects, time from induction of labor to delivery, unfavorable cervix	High quality review	Results of primary outcomes revealed no significant differences in rates of vaginal delivery not achieved within 24 hours (risk ratio (RR) 0.94, 95% confidence interval (CI) 0.78–1.14, two trials, 1,339 women) or caesarean section (RR 0.96, 95% CI 0.81–1.14, eight trials, 2,023 women). There was no difference in serious maternal morbidity or death (RR 1.24, 95% CI 0.55–2.82, one trial, 523 women), and no difference in serious neonatal morbidity or perinatal death (RR 0.84, 95% CI 0.23–3.12, one trial, 781 infants). Results of secondary outcomes revealed no difference between time from induction to delivery (mean difference (MD) -0.90 hours, 95% CI -2.28 to 0.49 hours; five studies), uterine rupture (RR 3.10, 95% CI 0.50–19.33; three trials), epidural analgesia (RR 1.03, 95% CI 0.89–1.18; two trials), instrumental birth (RR 1.22, 95% CI 0.88–1.66; three trials), Apgar less than seven at five minutes (RR 1.25, 95% CI 0.77–2.01, five trials), perinatal death (RR 0.84, 95% CI 0.23–3.12; two trials), postpartum haemorrhage (RR 1.08, 95% CI 0.87–1.34; five trials), or endometritis (RR 1.35, 95% CI 0.53–3.43; three trials). Removal of high bias studies reveals a significant reduction of induction to delivery interval (MD -1.94 hours, 95% CI -0.99 to -2.89 hours, 489 women). A significant increase in hyperstimulation without specifying fetal heart rate changes was found in the high-dose group (RR 1.86, 95% CI 1.55–2.25).
Kenyon 2013	Global	Systematic review and meta-analysis	Women in labor assessed as requiring augmentation by oxytocin for delay or slow progress in labor	High dose regimen	Low dose regimen	4 studies (644 women)	Perinatal mortality rate, neonatal mortality rate, cesarean section rate, women's satisfaction, length of labor, spontaneous vaginal birth, instrumental vaginal birth, incidence of hyperstimulation, incidence of ruptured uterus, diagnosis of chorioamnionitis,	High quality review	A higher dose of oxytocin was associated with a significant reduction in length of labor reported from one trial (mean difference (MD) -3.50 hours; 95% confidence interval (CI) -6.38 to -0.62; one trial, 40 women). There was a decrease in the rate of caesarean section (risk ratio (RR) 0.62; 95% CI 0.44–0.86 four trials, 644 women) and an increase in the rate of spontaneous vaginal birth in the high dose group (RR 1.35; 95% CI 1.13–1.62, three trials, 444 women), although for both of these outcomes there were inconsistencies between studies in the size of effect. When we carried out sensitivity analysis (temporarily removing a study at high risk of bias) the differences between groups were no longer statistically significant. There were no significant differences between high- and low-dose regimens for instrumental vaginal birth, epidural analgesia, hyperstimulation, postpartum hemorrhage, chorioamnionitis or women's perceptions of experiences. For neonatal outcomes, there was no significant difference between groups for Apgar scores, umbilical cord pH, admission to special care baby unit, or neonatal mortality. The following outcomes were not evaluated in the included

							incidence of postpartum hemorrhage, use of epidural analgesia, incidence of abnormal cardiotocography, incidence of women's pyrexia, incidence of dystocia, neonatal outcomes of Apgar scores, umbilical cord pH, neurological morbidity, admission to special care baby units		studies: perinatal mortality, uterine rupture, abnormal cardiotocography, women's pyrexia, dystocia and neonatal neurological morbidity.
Wei 2013	Global	Systematic review and meta-analysis	Pregnant women in spontaneous labor	Early augmentation with amniotomy and oxytocin	Conservative form of management	14 trials (8,033 women)	Cesarean section rate, delivery method, labor duration, use of epidural analgesia, maternal adverse effects, Apgar score, fetal adverse effects	High quality review	The unstratified analysis found early intervention with amniotomy and oxytocin to be associated with a modest reduction in the risk of caesarean section; however, the confidence interval (CI) included the null effect (risk ratio (RR) 0.89; 95% CI 0.79–1.01; 14 trials; 8,033 women). In prevention trials, early augmentation was associated with a modest reduction in the number of caesarean births (RR 0.87; 95% CI 0.77–0.99; 11 trials; 7,753). A policy of early amniotomy and early oxytocin was associated with a shortened duration of labor (average mean difference (MD) -1.28 hours; 95% CI -1.97 to -0.59; eight trials; 4,816 women). Sensitivity analyses excluding four trials with a full package of active management did not substantially affect the point estimate for risk of caesarean section (RR 0.87; 95% CI 0.73–1.05; 10 trials; 5,165 women). We found no other significant effects for the other indicators of maternal or neonatal morbidity.
Wei 2009	Global	Systematic review and meta-analysis	Women in labor	Early augmentation of labor with oxytocin	Conservative form of management	9 trials (1,983 women)	Cesarean delivery, spontaneous vaginal delivery, operative vaginal delivery, duration of labor, analgesia, hyperstimulation of labor, postpartum	High quality review	Early oxytocin was associated with an increase in the probability of spontaneous vaginal delivery (RR 1.09, 95% CI 1.03–1.17). For every 20 patients treated with early oxytocin augmentation, one additional spontaneous vaginal delivery is expected. Although the point estimate for the effect on cesarean delivery (RR 0.87, 95% CI 0.71–1.06) and on operative vaginal delivery (RR 0.84, 95% CI 0.70–1.00) showed modest protective effects, the CIs for both estimates included the null effect. A decrease in antibiotic use (RR 0.45, 95% CI 0.21–0.99) was observed with early intervention. Early oxytocin was associated with an increased risk of hyperstimulation

							hemorrhage, maternal blood transfusion, antibiotic use, vaginal tears, and neonatal complications		(RR 2.90, 95% CI 1.21–6.94) without evidence of adverse neonatal effects. Women in the early oxytocin group reported higher levels of pain and discomfort in labor.
Howarth 2001	Global	Systematic review and meta-analysis	Women due for third trimester induction of labor, with a viable fetus	Amniotomy plus oxytocin	Placebo/no treatment or other methods of induction of labor	17 trials (2,566 women)	Vaginal delivery not achieved within 24 hours, uterine hyperstimulation with fetal heart rate (FHR) changes, caesarean section, serious neonatal morbidity or perinatal death, serious maternal morbidity or death, maternal adverse effects, satisfaction	High quality review	Amniotomy and intravenous oxytocin were found to result in fewer women being undelivered vaginally at 24 hours than amniotomy alone (relative risk (RR) 0.03, 95% CI 0.001–0.49). This finding was based on the results of a single study of 100 women. As regards secondary results amniotomy and intravenous oxytocin resulted in significantly fewer instrumental vaginal deliveries than placebo (RR 0.18, CI 0.05–0.58). Amniotomy and intravenous oxytocin resulted in more postpartum hemorrhage than vaginal prostaglandins (RR 5.5, CI 1.26–24.07). Significantly more women were also dissatisfied with amniotomy and intravenous oxytocin when compared with vaginal prostaglandins, RR 53, CI 3.32–846.51.
Boie 2021	Denmark	Randomized controlled trial	Women at a gestational age of 37–42 complete weeks of pregnancy, who have uterine activity stimulated with oxytocin infusion for the induction of labor	Oxytocin infusion (continuous group)	Placebo infusion (discontinued group)	1,200 women	Delivery by caesarean section	High risk of bias	A total of 607 women were assigned to discontinuation and 593 to continuation of the oxytocin infusion. The rates of caesarean section were 16.6% (n=101) in the discontinued group and 14.2% (n=84) in the continued group (relative risk 1.17, 95% confidence interval 0.90–1.53). In 94 parous women with no previous caesarean section, the caesarean section rate was 7.5% (11/147) in the discontinued group and 0.6% (1/155)in the continued group (relative risk 11.6, 1.15–88.7). Discontinuation was associated with longer duration of labour (median from randomisation to delivery 282 v 201 min; *P*<.001), a reduced risk of hyperstimulation (20/546 (3.7%) v 70/541 (12.9%); *P*<.001), and a reduced risk of fetal heart rate abnormalities (153/548 (27.9%) v 219/537 (40.8%); *P*<.001) but rates of other adverse maternal and neonatal outcomes were similar between groups.
Selin 2019	Sweden	Randomized controlled trial	Nulliparous women at term with singleton	High-dose oxytocin	Low-dose oxytocin	1,295 women	Rate of cesarean section in labor, instrumental vaginal birth,	Low risk of bias	Caesarean section rates did not differ between groups (12.4% and 12.3%, 95% CI -3.7 to 3.8). Women with high-dose oxytocin had: shorter labors (-23.4 min); more uterine tachysystole (43.2% versus 33.5%); similar rates of instrumental vaginal births, with more due to fetal distress (43.8%

			cephalic fetal presentation				spontaneous vaginal birth, main indication for cesarean section and instrumental vaginal birth, duration of labor, postpartum hemorrhage, manual removal of placenta, anal sphincter injury, fever during labor, uterine tachysystole, total dose of oxytocin, maximum oxytocin dose per minute, total duration of oxytocin infusion, oxytocin stopped or reduced temporarily, oxytocin stopped or reduced temporarily due to tachysystole together with suspicious or pathological FHR pattern; adverse neonatal outcomes		versus 22.7%) and fewer due to failure to progress (39.6% versus 58.8%). There were no differences in neonatal outcomes.
Titulaer 2019	Netherlands	Randomized controlled trial	Women with term, singleton pregnancy in vertex position undergoing labor induction	Amniotomy with 12-hours delayed oxytocin (DO)	Amniotomy with immediate oxytocin (IO)	64 women	Amniotomy-to-delivery interval and patient reported experience	High risk of bias	The median amniotomy-to-delivery interval for the DO-group was 15 hours (IQR 8–21), and 6 hours (IQR 5–11) for the IO-group (HR, 0.41; 95% CI 0.24–0.70), with equal patient reported childbirth perception in the overall group (*P*=.43). Parous women reported a significantly less positive perception of labor (*P*=.02) and used pain relief more often (RR, 2.93; 95% CI 1.05–8.19) in the DO-group. The proportion of women delivered within 24 hours was not significantly different between groups (RR, 0.30; 95% CI 0.05–1.83). Other delivery and

									neonatal outcomes did not differ significantly between groups, possibly due to being underpowered.
Bor 2016	Denmark	Randomized controlled trial	Women with singleton pregnancy in the vertex position undergoing labor induction or augmentation	Continue oxytocin infusion	Discontinue oxytocin infusion	200 women	Duration of the active phase of labor, mode of delivery, uterine tachysystole, hyperstimulation, abnormalities in fetal heart rate, postpartum hemorrhage rate, perineal tears, and neonatal outcomes	High risk of bias	The active phase of labor was longer by 41 minutes (95% confidence interval 11–75 minutes) in the discontinued group (median 125 minutes in 85 women who had reached the active phase and delivered vaginally) versus the continued group (median 88 minutes in 78 women). The incidence of fetal heart rate abnormalities (51 versus 20%) and uterine hyperstimulation (12 versus 2%) was significantly greater in the continued than the discontinued oxytocin group. The incidence of tachysystole, cesarean deliveries, postpartum hemorrhage, third degree perineal tears and adverse neonatal outcomes was higher in the continued group but did not reach significance.
Diven 2012	United States	Randomized controlled trial	Women who underwent induction of labor at term	Oxytocin discontinuation (DC)	Routine oxytocin use (routine)	252 patients	Cesarean delivery	High risk of bias	Cesarean delivery rate was similar between the groups (routine, 25.2% [n=32] vs the DC group, 19.2% [n=24]; *P*=.25). There was a higher chorioamnionitis rate and slightly longer active phase in those women who were assigned to the DC group. In adjusted analysis, the rate of chorioamnionitis was not different by randomization group but was explained by the duration of membrane rupture and intrauterine pressure catheter placement.
Nachum 2010	Israel	Randomized controlled trial	Women with a singleton fetus in cephalic presentation who have a prolonged latent phase	Amniotomy; oxytocin; both amniotomy and oxytocin	Spontaneous progression	283 women	Duration of time from initiation of augmentation until delivery	Low risk of bias	A mean reduction of 120 minutes in labor duration was observed among group 3 compared to group 1 (*P*=.08) and 180 minutes compared to group 2 and 4 (*P*=.001). Women in group 3 had a shorter length of time from augmentation until the beginning of the active phase and a shorter first stage of labor than group 1 (*P*=.03), group 2 (*P*=.001) and group 4 (*P*=.001). Satisfaction was greater among group 3 and 4. Mode of delivery and neonatal outcome were comparable between the groups.
Dencker 2009	Sweden	Randomized controlled trial	Nulliparous women with normal pregnancies, spontaneous onset of active labour, a cervical dilatation of 4–9 cm and no progress in	Labor augmentation by oxytocin infusion (early oxytocin group)	Postponement of oxytocin augmentation for another 3 hours (expectant group)	630 women	Mode of delivery (spontaneous vaginal or instrumental vaginal delivery or caesarean section), time from randomization to delivery	High risk of bias	The caesarean section rate was 29 of 314 (9%) in the early oxytocin group and 34 of 316 (11%) in the expectant group (OR 0.8, 95% CI 0.5–1.4), and instrumental vaginal delivery 54 of 314 (17%) in the early oxytocin versus 38 of 316 (12%) in the expectant group (OR 1.5, 95% CI 0.97–2.4). Early initiation of oxytocin resulted in a mean decrease of 85 minutes in the randomization to delivery interval.

			cervical dilatation for 2 hours						
Selo-Ojeme 2009	United Kingdom	Randomized controlled trial	Nulliparous women with singleton term pregnancy in cephalic presentation and with intact membranes, no regular uterine contractions, a favorable cervix, no significant fetal or maternal medical conditions and no previous uterine surgery	Amniotomy and immediate oxytocin infusion (immediate group)	Amniotomy and delayed oxytocin infusion (delayed group)	123 women	Proportion of women in established labor at 4 hours, the proportion that delivered within 12 hours of amniotomy	High risk of bias	Women in the immediate group were more likely to be in established labor 4 hours post-amniotomy [relative risk (RR) 12.8; 95% CI 55.1–111.7], have a shorter amniotomy to delivery interval (*P*<.001) and achieve vaginal delivery within 12 h (RR 1.5; 95% CI 1.2–12.6). There was no difference between the groups with regards to the mode of delivery, incidence of uterine hyperstimulation and abnormal fetal heart rate recording. Compared to the delayed group, women in the immediate group were more likely to be satisfied with the induction process (RR 4.1, 95% CI 1.1–16.1) and the duration of labor (RR 1.8 95% CI 1.0–3.3).
Bolnick 2004	United States	Randomized controlled trial	Pregnancies that underwent labor induction at R37 weeks of gestation with an unfavorable cervix	Single dose of sustained-release dinoprostone (Cervidil) with concurrent low-dose oxytocin	Multidosing of misoprostol (25 mg every 4 hours) followed by high-dose oxytocin	151 patients	Time interval from induction to vaginal delivery, excess uterine Activity, cesarean delivery rates	Low risk of bias	The mean time from the initiation of induction to vaginal delivery was the same in the dinoprostone and misoprostol groups (15.7 hours; 95% CI 13.7–17.7 hours vs 16.0 hours; 95% CI 14.1–17.8 hours; *P*=.34), regardless of parity. The dinoprostone and misoprostol groups did not differ statistically in the percent of patients who were delivered vaginally by 12 hours (36.2% vs 29.7%), 18 hours (63.8% vs 56.3%), and 24 hours (81.0% vs 81.3%). Excess uterine activity was not more common in either group, and hyperstimulation syndrome was absent in all cases. Primary cesarean delivery rates were similar (dinoprostone, 21.6%; misoprostol, 16.9%; relative risk, 1.3; 95% CI 0.7–2.5), with a failed induction that occurred in one case in each group.
Prichard 2019	Australia	Retrospective cohort	Term (37+0-week gestation or later), singleton, nulliparous women undergoing induction with oxytocin	Induction with low-dose regimen	Induction with high-dose regimen	4,885 participants	Caesarean section rate, instrumental delivery rate, length of active labor	Moderate risk of bias	2,211 were induced via the low-dose regimen, and 2,674 using the high-dose regimen. There was no difference in cesarean section rate (adjusted OR 0.99; 95% CI 0.87–1.13) or instrumental delivery rates once adjusted for regional anesthesia (adjusted OR 1.16; 95% CI 0.99–1.36) between the different regimens. Surprisingly, the length of labor was longer in the high-dose oxytocin group (adjusted mean difference 0.60 hours; 95% CI 0.81–0.12). There were significantly more postpartum hemorrhage 1000ml or more (10.5% versus 7.8%, *P*<.001) and regional anaesthesia use (55.8% versus 52.1%, *P*=.03) in the low-dose cohort. There were no differences in neonatal outcomes.

Bernitz 2014	Norway	Cohort	Low-risk nulliparous women	Augmentation with dystocia	Augmentation with no dystocia	747 women	Incidence of oxytocin augmentation associations between dystocia and augmentation, mode of delivery, transfer to NICU, episiotomy, postpartum hemorrhage	Moderate risk of bias	43.8% were augmented with oxytocin of which 42.5% did not fulfill the criteria for dystocia. Analyses adjusted for possible confounders found that women without dystocia had an increased risk of instrumental vaginal birth (OR 3.73, CI 1.93–7.21) and episiotomy (OR 2.47, CI 1.38–4.39) if augmented with oxytocin. Augmented women had longer active phase if vaginally delivered and longer labors if delivered by caesarean section if having dystocia. Among women without dystocia, those augmented had higher body mass index, gave birth to heavier babies, had longer labors if vaginally delivered and had epidural analgesia more often compared to women not augmented.
Gross 2014	Germany	Longitudinal cohort	Nulliparae and multiparae with a singleton in cephalic presentation	Administration of amniotomy, oxytocin initiation or neuraxial analgesia	n/a	3,963 women	Labor duration, complete dilatation, spontaneous or operative vaginal delivery or cesarean delivery, adverse maternal and fetal outcomes	Moderate risk of bias	From amniotomy onwards labor was accelerated. In multiparae, amniotomy was associated with an initial 6.6-fold acceleration, decreasing first stage duration until the hazard ratio reached around 3.5, where the intervention was performed 5 hours after labor onset; thereafter, acceleration continued with a hazard ratio of around 3. In nulliparae, neuraxial analgesia was associated with a shorter first stage when administered between 7 and 11 hours after labor onset; the later it was performed, the less likely was spontaneous birth and the more likely an operative vaginal birth in nulliparae or a caesarean section in multiparae. The start of oxytocin augmentation was associated with acceleration towards both full dilatation and caesarean section during first stage and an increased risk of operative vaginal birth during second stage. The later oxytocin augmentation started, the more likely it was that spontaneous birth would be retarded in multiparous women.
Soni 2013	United States	Retrospective observational	Subjects in spontaneous labor whose arrest of dilatation was treated with oxytocin	Body mass index (BMI): Group A, less than 25 kg/m^2	Group B, 25.0–29.9 kg/m^2; Group C, 30.0–34.9 kg/m^2; and Group D, 35 kg/m^2 or greater	118 subjects	Progression to full cervical dilatation, post-arrest slope is greater than or equal to pre-arrest slope, cesarean delivery	Moderate risk of bias	Full dilatation was reached in about 90% of Group A and B, 72% of Group C, and 39% of Group D, the most obese women (P<.001). The cesarean rate was directly related to maternal BMI, 11.4%, 22.9%, 34.3%, and 69.6% in Groups A through D, respectively (P<.001). Significantly more oxytocin was used in group D than in the other groups during the first 3 hours of infusion in attempting to overcome the arrest (P=.003).
Rouse 2001	United States	Observational	Spontaneously laboring term women with abnormally progressive labor	Standardized protocol: oxytocin and intrauterine pressure catheter with an intent to	n/a	501 women	Maternal and neonatal outcomes	Serious risk of bias	During oxytocin augmentation, nulliparas who were delivered vaginally dilated at a median rate of 1.4 cm/hour versus 1.8 cm/hour for parous women. In both groups, the 5th percentile of cervical dilation rate was 0.5 cm/hour. Thirty-eight women experienced labor arrest for over 2 hours despite at least 200 sustained Montevideo units; 23 (61%) achieved a vaginal delivery. Rates of chorioamnionitis and endometritis for the 38

				sustain at least 200 Montevideo units for 4 hours or more					women were 26%. None of their infants sustained a serious complication, including brachial plexus injury, even though three of the 23 vaginal deliveries (13%) were complicated by shoulder dystocia.
Special Adjunctive Considerations									
Myers 2020 (Labor Dystocia AHRQ report)	Global	Systematic review	Women aged 15-44 with uncomplicated pregnancy at 37–42 weeks gestation with a singleton pregnancy with vertex presentation	Emotional support, ambulation, routine maternal oxygen supplementation, specific nutritional recommendations or limitations, specific oral or parenteral hydration recommendations or limitations, peanut ball, Lamaze, hypnobirthing, positioning, acupuncture, hydrotherapy	Usual care; interventions above compared to each other	64 articles	Adverse maternal effects, adverse neonatal effects, labor progress	High quality review	Supportive care measures during labor encompass a wide variety of interventions and within individual categories of interventions, there is considerable heterogeneity in the nature and timing of the interventions. Although supportive care therapies are often seen as increasing parental satisfaction with the birthing process, these outcomes were only assessed in five of the included RCTs with sparse evidence. An earlier SR of 11 studies however did find that women receiving continuous emotional support were less likely to rate their birth experience negatively (moderate SOE). Two studies addressing continuous emotional support included in the present review did not show a benefit in reducing 1st or 2nd stage labor duration, although prior SR/MAs of 12 studies (including these two studies) indicated a benefit for total labor duration (moderate SOE). Emotional support interventions reduced cesarean deliveries (low SOE for doula support, moderate SOE for continuous emotional support) and instrumental deliveries (moderate SOE). There was no difference in rates of cesarean deliveries for women receiving perineal compresses or massage (low SOE), but severe perineal trauma was reduced in nulliparous women (low SOE). There was no difference in duration of labor in women using water birth (low SOE). Women undergoing acupuncture/ acupoint nerve stimulator did not experience differences in labor duration or rates of maternal hemorrhage (low SOE for both outcomes). Ambulation was associated with shorter duration of labor (low SOE). No differences were found in duration of labor (low SOE) or cesarean delivery rates (moderate SOE) for women using differing positioning interventions. Women in kneeling position were more likely than women in sitting position to have reduced trauma to the pelvic floor (low SOE). Administration of intravenous fluids compared with oral intake alone demonstrated a reduction in the duration of labor (low SOE), while not increasing cesarean delivery rates (moderate SOE), maternal hemorrhage (low SOE), or operative vaginal delivery rates (moderate SOE).
Grenvik 2019	Global	Systematic review and	Laboring women with singleton gestations in	Use of peanut ball	No use of peanut ball	4 trials (648 participants)	Total length of labor, length of the first stage and	High quality review	Total length of labor was 79 min shorter in the peanut ball group, but this was not significant (MD -79.1 min, 95% CI -04.9 to 46.7). Peanut ball use showed trends toward higher incidence of spontaneous vaginal deliveries (RR 1.1, 95% CI

		meta-analysis	cephalic presentation at term				second stage of labor, mode of delivery, and neonatal outcomes, including birth weight, Apgar score		1.0–1.2) and lower incidence of cesarean deliveries (RR 0.8, 95% CI 0.6–1.0).
Bohren 2017	Global	Systematic review and meta-analysis	Women during childbirth	Continuous support	Usual care	27 trials (15,858 women)	Spontaneous vaginal birth, negative rating of/negative feelings about birth experiences, postpartum depression, admission to special care nursery, exclusive or any breastfeeding, labor length, Cesarean birth	High quality review	Women allocated to continuous support were more likely to have a spontaneous vaginal birth (average RR 1.08, 95% confidence interval (CI) 1.04–1.12; 21 trials, 14,369 women; low-quality evidence) and less likely to report negative ratings of or feelings about their childbirth experience (average RR 0.69, 95% CI 0.59–0.79; 11 trials, 11,133 women; and to use any intrapartum analgesia (average RR 0.90, 95% CI 0.84–0.96; 15 trials, 12,433 women). In addition, their labours were shorter (MD -0.69 hours, 95% CI -1.04 to -0.34; 13 trials, 5,429 women; low-quality evidence), they were less likely to have a caesarean birth (average RR 0.75, 95% CI 0.64–0.88; 24 trials, 15,347 women; low-quality evidence) or instrumental vaginal birth (RR 0.90, 95% CI 0.85–0.96; 19 trials, 14,118 women), regional analgesia (average RR 0.93, 95% CI 0.88–0.99; 9 trials, 11,444 women), or a baby with a low five-minute Apgar score (RR 0.62, 95% CI 0.46–0.85; 14 trials, 12,615 women). Data from two trials for postpartum depression were not combined due to differences in women, hospitals and care providers included; both trials found fewer women developed depressive symptomatology if they had been supported in birth, although this may have been a chance result in one of the studies. There was no apparent impact on other intrapartum interventions, maternal or neonatal complications, such as admission to special care nursery (average RR 0.97, 95% CI 0.76–1.25; 7 trials, 8,897 women; low-quality evidence), and exclusive or any breastfeeding at any time point (average RR 1.05, 95% CI 0.96–1.16; 4 trials, 5,584 women).
Ehsanipoor 2017	Global	Systematic review and meta-analysis	Nulliparous women in spontaneous labor at term with singleton pregnancies at 36 weeks or more	Intravenous fluid rates of 250 mL/h	Intravenous fluid rates of 125 mL/h	7 trials (1,215 women)	Incidence of cesarean delivery	High quality review	593 (48.8%) in the 250 mL/h group, and 622 (51.2%) in the 125 mL/h group. Five studies used lactated Ringer's solution, one used normal saline in dextrose water, and in one study it was unclear which intravenous fluid was used. Women who received intravenous fluids at 250 mL/h had a significantly lower incidence of cesarean delivery for any indication (12.5 vs. 18.1%; RR 0.70, 95% CI 0.53–0.92; seven studies, 1,215 participants; I^2=0%) and for dystocia (4.9 vs. 7.7%; RR 0.60, 95% CI 0.38–0.97; five studies, 1,093 participants; I^2=18%), a significantly shorter mean duration of labor of about one hour (mean difference 64.38 min, 95% CI -121.88 to -6.88; six studies, 1,155 participants; I^2=83%) and a significantly shorter

									mean length of second stage of labor (mean difference -2.80 min, 95% CI -4.49 to -1.10; 899 participants; I^2=22%) compared with those who received intravenous fluid at 125 mL/h. No differences were found in the other secondary outcomes. There were no maternal or perinatal deaths and only one woman, in the 125 mL/h group, developed pulmonary edema. The findings persisted regardless of the type of intravenous fluid used. No significant reduction in the incidence of cesarean delivery was demonstrated in women with unrestricted oral intake; however, this was limited to only two studies evaluating 254 women.
Kobayashi 2017	Global	Systematic review and meta-analysis	Healthy pregnant women	Assessment	Direct admission to hospital in early labor	5 trials (10,421 women)	Length of labor, rate of cesarean section, rate of instrumental vaginal birth, serious maternal morbidity, use of epidural or any regional anesthesia, neonatal admission to special care, Apgar score	High quality review	One trial with 209 women compared early labor assessment with direct admission to hospital. Duration of labor from hospital admission was reduced for women in the assessment group (mean difference (MD) -5.20 hours, 95% confidence interval (CI) -7.06 to -3.34; 209 women). There were no clear differences between groups for caesarean section or instrumental vaginal birth (risk ratio (RR) 0.72, 95% CI 0.30–1.72 and, RR 0.86, 95% CI 0.58–1.26). Serious maternal morbidity was not reported. Women in the early assessment group were slightly less likely to have epidural or oxytocin for labor augmentation (RR 0.87, 95% CI 0.78–0.98; RR 0.57, 95% CI 0.37–0.86) and increased satisfaction with their care (MD 16.00, 95% CI 7.53–24.47). No babies were born before admission to hospital and only one infant had a low Apgar score at five minutes after the birth. Three studies examined home assessment and midwifery support versus telephone triage. One trial reported the duration of labor; home visits did not have any clear impact compared with usual care (MD 0.29 hours, 95% CI -0.14 to 0.72; 1 trial, 3,474 women). There were no clear differences for the rate of caesarean section (RR 1.05, 95% CI 0.95–1.17; 3 trials, 5,170 women; IQ=0%) or instrumental vaginal birth (average RR 0.95, 95% CI 0.79–1.15; 2 trials, 4,933 women; IQ=69%). One trial reported birth before arrival at hospital; there was no clear difference between the groups (RR 1.33, 95% CI 0.30–5.95;1 trial, 3,474 women). No clear differences were identified for serious maternal morbidity (RR 0.93, 95% CI 0.61–1.42; 1 trial, 3,474 women), or use of epidural (average RR 0.95, 95% CI 0.87–1.05; 3 trials, 5,168 women; IQ=60%). There were no clear differences for NICU admission (average RR 0.84, 95% CI 0.50–1.42; 3 trials, 5,170 infants; IQ=71%), or for low Apgar score at five minutes (RR 1.19, 95% CI 0.71–1.99; 3 trials, 5,170 infants; IQ=0%). One study (5,002 women) examined one-to-one structured care in early labor versus usual care. Length of labor was not reported. There were no clear differences between groups for caesarean section (RR 0.93, 95% CI 0.84–1.02; 4,996 women) instrumental vaginal birth (RR 0.94, 95% CI 0.82–1.08; 4,996 women), or serious maternal

									morbidity (RR 1.13, 95% CI 0.84–1.52; 4,996 women). Use of epidural was similar in the two groups (RR 1.00, 95% CI 0.99–1.01; 4,996 women). For infant outcomes, there were no clear differences between groups (admission to NICU: RR 0.98, 95% CI 0.80–1.21; 4,989 infants; low Apgar score at five minutes: RR 1.07, 95% CI 0.64–1.79; 4,989 infants). A cluster randomized trial with 2,183 women examined a labor diagnosis tool used by midwives compared with usual assessment. There were no clear differences between groups for most of the outcomes measured. Interventions in labor (augmentation with oxytocin (RD 0.3, 95% CI -9.2 to 9.8), epidural (RD 2.1, 95% CI -8.0 to 12.2), instrumental or caesarean birth (spontaneous vertex birth RD -3.2, 95% CI -15.1 to 8.7)) were similar between groups after adjustment for baseline differences between maternity units. Women in the intervention group were less likely to be admitted to hospital at first presentation. There were no clear differences between groups for infant outcome.
Pergialiotis 2016	Global	Meta-analysis	Laboring women	Propranolol co-administration with oxytocin	Oxytocin alone	Six studies (609 parturient)	Maternal and neonatal outcomes		Propranolol administration during the latent phase effectively reduces the cesarean section rates (OR 0.49, 95 % CI 0.27–0.89). However, this beneficial effect is not observed during the active phase of labor. The 5 min neonatal Apgar scores are not influenced by its administration (MD -0.07, 95 % CI -0.017, 0.02). Respectively, the neonatal admissions to a NICU are similar to those of neonates exposed only to oxytocin (OR 0.96, 95 % CI 0.36–2.53).
Mollart 2015	Global	Systematic review	Primiparous and/or multiparous women with either spontaneous or induced onset of labor	Acupressure	Placebo and no treatment	7 trials (748 women)	Labor onset, duration of all stages of labor	Moderate quality review	One study examined the initiation of labor and six studies examined labor duration and/or pain levels. The two most studied acupoints were Sanyinjiao/Spleen 6 and Hegu/Large Intestine 4. Results suggest acupressure may reduce the length of labor particularly in the first stage.
Lawrence 2013	Global	Systematic review and meta-analysis	Women in the first stage of labor	Upright and ambulant positions (comparison 1 included no epidural, comparison 2 included epidural)	Recumbent positions and bed care	25 trials (5,218 women)	Duration of first stage of labor, mode of birth, maternal satisfaction, fetal distress, use of neonatal mechanical ventilation, pain, use of analgesics, duration of second stage of labor, augmentation of	High quality review	For Comparison 1: Upright and ambulant positions versus recumbent positions and bed care, the first stage of labor was approximately one hour and 22 minutes shorter for women randomized to upright as opposed to recumbent positions (average MD -1.36, 95% confidence interval (CI) -2.22 to -0.51; 15 studies, 2,503 women; random-effects, T2=2.39, Chi2=203.55, df=14, (*P*<.00001), I^2=93%). Women who were upright were also less likely to have cesarean section (RR 0.71, 95% CI 0.54–0.94; 14 studies, 2,682 women) and less likely to have an epidural (RR 0.81, 95% CI 0.66–0.99, nine studies, 2,107 women; random-effects, T2=0.02, I^2=61%). Babies of mothers who were upright were less likely to be admitted to the neonatal intensive care unit, however this was based on one trial (RR 0.20, 95% CI 0.04–0.89, one study, 200 women). There were no significant differences between

							labor with oxytocin, AROM, hypotension, blood loss, perineal trauma, Apgar scores, admission to neonatal intensive care unit, perinatal death		groups for other outcomes including duration of the second stage of labor, or other outcomes related to the well-being of mothers and babies. For Comparison 2: Upright and ambulant positions versus recumbent positions and bed care (with epidural: all women), there were no significant differences between groups for outcomes including duration of the second stage of labor, or other outcomes related to the well-being of mothers and babies.
Hunter 2007	Global	Systematic review and meta-analysis	Women with lateral or posterior fetal positions in late pregnancy or labor, or women with any fetal positions	Variations of the hands and knees posture	Alternative postures	3 trials (2,794 women)	Change in fetal position, fetal position during labor and at delivery, duration of labor, pain scores, analgesia used, method of delivery, perinatal outcomes, maternal satisfaction	High quality review	In one trial (100 women), four different postures (four groups of 20 women) were combined for the comparison with the control group of 20 women. Lateral or posterior position of the presenting part of the fetus was less likely to persist following 10 minutes in the hands and knees position compared to a sitting position (one trial, 100 women, relative risk (RR) 0.26, 95% confidence interval (CI) 0.18–0.38). In a second trial (2,547 women), advice to assume the hands and knees posture for 10 minutes twice daily in the last weeks of pregnancy had no effect on the baby's position at delivery or any of the other pregnancy outcomes measured. The third trial studied the use of hands and knees position in labor and involved 147 laboring women at 37 or more weeks gestation. Occiput posterior position of the baby was confirmed by ultrasound. Seventy women, who were randomized in the intervention group, assumed hands and knees positioning for a period of at least 30 minutes, compared to 77 women in the control group who did not assume hands and knees positioning in labor. The reduction in occiput posterior or -transverse positions at delivery and operative deliveries were not statistically significant. There was a significant reduction in back pain.
Roberts 2004	Global	Systematic review and meta-analysis	Women with epidural analgesia	Ambulation or upright position	Recumbency	5 RCTs (1,161 women)	Instrumental delivery, cesarean section, spontaneous vaginal delivery, oxytocin augmentation, length of first stage, length of second stage, perineal laceration, postpartum hemorrhage,	Moderate quality review	There was no statistically significant difference in the mode of delivery when women with an epidural ambulated in the first stage of labor compared with those who remained recumbent: instrumental delivery (relative risk (RR)=1.16, 95% CI 0.93–1.44) and Caesarean section (RR=0.91, 95% CI 0.70–1.19). There were no significant differences between the groups in use of oxytocin augmentation, the duration of labor, satisfaction with analgesia or Apgar scores. There were no apparent adverse effects of ambulation, but data were reported by only a few trials.

							inadequate pain relief, satisfaction with labor care and longer-term outcomes, including urinary or fecal incontinence and sexual problems or back ache		
McCoy 2023	United States	Randomized control trial	Pregnant women 36 weeks or more with a singleton gestation and prolonged labor	Intravenous (IV) propranolol	Placebo	164 women	Rates of cesarian delivery	Low risk of bias	In this multisite, double-blind, placebo-controlled randomized trial, there was no difference in cesarean delivery rate for patients who received propranolol compared with those who received placebo for management of prolonged labor.
Bueno Lopez 2018	Spain	Randomized controlled trial	Women in labor with fetuses in persistent occiput posterior (POP) position	Modified Sims on the side of the fetal spine	Free position	120 women	Rotation to occiput anterior, type of delivery, postpartum perineal condition, perinatal results, maternal satisfaction	High risk of bias	In pregnant women undergoing labor in the Sims position, fetuses in POP rotated to occiput anterior in 50.8% of cases, whilst in the free position group, the rotation occurred in 21.7% (*P*=.001). The rate of vaginal deliveries was higher in the Sims group compared with the free position group (84.7% vs 68.3%, *P*=.035).
Mercier 2018	United States	Randomized controlled trial	Women older than 18 years of age with singleton pregnancies	Use of peanut ball	Usual care	96 patients	Rate of cervical dilation, rates of cesarean delivery, fetal presentation at time of full dilation or delivery	High risk of bias	There was no statistically significant difference in rates of cervical dilation (0.98 cm/h vs. 0.79 cm/h, *P*=.27) or length of labor (315 minutes vs. 387 minutes, *P*=.14) between the groups. There was no difference in the rates of cesarean delivery (33% vs. 35%, *P*=.8) or occiput posterior presentation. (28% vs. 9%, *P*=.09). Among the subgroup who had labor arrest, fewer patients using the peanut ball experienced arrest of dilation; this approached but did not reach statistical significance (30% vs. 73% *P*=.05).
Bick 2017	United Kingdom	Randomized controlled trial	Nulliparous women aged ≥ 16 years, at ≥ 37 weeks' gestation with singleton cephalic presentation and intended SVB, in second-stage	Upright position to maintain the pelvis in as vertical a plane as possible	Lying-down position to maintain the pelvis in as horizontal a plane as possible	3,236 women	Incidence of spontaneous vaginal birth (SVB)	High risk of bias	There was a statistically significant difference in the incidence of SVB between groups, with 35.2% of women achieving a SVB in the upright group, compared with 41.1% in the lying-down group (adjusted risk ratio 0.86, 95% confidence interval 0.78–0.94). There was no evidence of differences in most of the secondary maternal or neonatal outcomes, or in long-term outcomes at the 12-month follow-up. No significant overall cost differences were observed between upright and lying-down positions for mothers or their babies.

			labour with an epidural providing effective pain relief						
Fong 2017	United States	Randomized controlled trial	Nulliparous subjects with singletons who presented in active labor	High-dose intravenous fluids, high-dose fluids with dextrose	Standard-dose fluids with dextrose	274 subjects	Total length of labor, clinical chorioamnionitis, postpartum hemorrhage, blood loss, Apgar scores, neonatal intensive care admission	Low risk of bias	There were no differences in baseline characteristics among the 3 groups. There was no difference in the primary outcome of total length of labor in vaginally delivered subjects among the 3 groups. First stage of labor duration, second stage of labor duration, and cesarean delivery rates were also equivalent. There were no differences identified in other secondary outcomes including clinical chorioamnionitis, postpartum hemorrhage, blood loss, Apgar scores, or neonatal intensive care admission.
Roth 2016	United States	Randomized controlled trial	Women scheduled for elective induction of labor at 39 weeks or later gestation and planning an epidural	Use of peanut ball	No use of peanut ball	200 women	Time spent in first stage labor; time spent pushing	High risk of bias	Among women having elective induction with epidural analgesia, use of a peanut ball reduced first stage labor duration for primiparous patients significantly more than multiparous patients, *P*=.018. There was no significant difference in the reduction of length of first stage labor for multiparous women, *P*=.057 with use of the peanut ball. Peanut ball use did not alter length of pushing time for either group, *P*>.05.
Guittier 2014	Switzerland	Randomized controlled trial	Women with a fetus in occiput posterior (OP) position during the first stage of labor	Hands and knees' positions	Expectant management	438 women	Position of the fetal head, evaluation of the comfort of maternal positions; impact of the maternal position on the perceived pain; duration of the first and second stage of labor; mode of delivery according to the fetal head position; perineal status; neonate data	Ongoing study	n/a
Altman 2007	Sweden	Multivariate risk Analysis of RCT	Primiparous women with normal pregnancies and	Kneeling position	Sitting position	271 women	Obstetric sphincter lacerations	Low risk of bias	There were no significant differences with regard to duration of second stage of labor or pre-trial maternal characteristics between the two groups. Obstetrical sphincter tears did not differ significantly between the two groups, but an intact

			spontaneous labor						perineum was more common in the kneeling group (*P*<.03) and episiotomy (mediolateral) was more common in the sitting group (*P*<.05). Three grade IV sphincter lacerations occurred in the sitting group compared to none in the kneeling group (NS). Multivariate risk analysis indicated that prolonged duration of second stage of labor and episiotomy were associated with an increased risk of third- or fourth-degree sphincter tears (*P*<.01 and *P*<.05, respectively). Delivery posture, maternal age, fetal weight, use of oxytocin, and use of epidural analgesia did not increase the risk of obstetrical anal sphincter lacerations in the two upright postures.
Stremler 2005	Argentina, Australia, Canada, England, Israel, United States	Randomized controlled trial	Women laboring with a fetus at 37 weeks' gestation or later and confirmed by ultrasound to be in occiput posterior position	Hands-and-knees positioning for at least 30 minutes over a 1-hour period during labor	No hands-and-knees positioning	147 women	Fetal head rotation, persistent back pain, women's experience, labor and delivery outcomes	High risk of bias	Women randomized to the intervention group had significant reductions in persistent back pain. Eleven women (16%) allocated to use hands-and-knees positioning had fetal heads in occiput anterior position following the 1-hour study period compared with 5 (7%) in the control group (relative risk 2.4; 95% CI 0.88–6.62; number needed to treat 11). Trends toward benefit for the intervention group were seen for several other outcomes, including operative delivery, fetal head position at delivery, 1-minute Apgar scores, and time to delivery.
Cluett 2004	United Kingdom	Randomized controlled trial	Nulliparous women with dystocia (cervical dilation rate less than 1 cm/hour in active labor) at low risk of complications	Immersion in water in birth pool	Standard augmentation for dystocia (amniotomy and intravenous oxytocin)	99 women	Epidural analgesia, operative delivery rates, augmentation rates with amniotomy and oxytocin, length of labor, maternal and neonatal morbidity including infections, maternal pain score, maternal satisfaction with care	High risk of bias	Women randomized to immersion in water had a lower rate of epidural analgesia than women allocated to augmentation (47% v 66%, relative risk 0.71 (95% confidence interval 0.49–1.01), number needed to treat for benefit (NNT) 5). They showed no difference in rates of operative delivery (49% v 50%, 0.98 (0.65–1.47), NNT 98), but significantly fewer received augmentation (71% v 96%, 0.74 (0.59–0.88), NNT 4) or any form of obstetric intervention (amniotomy, oxytocin, epidural, or operative delivery) (80% v 98%, 0.81 (0.67–0.92), NNT 5). More neonates of women in the water group were admitted to the neonatal unit (6 v 0, *P*=.013), but there was no difference in Apgar score, infection rates, or umbilical cord pH.
Frenea 2004	France	Randomized controlled trial	Parturients with singleton pregnancy from 37–42 weeks of gestation in a fixed cephalic,	Recumbent	Ambulate	61 parturients	Duration of labor, pain scores, type of delivery, maternal blood pressure,	Unclear/high risk of bias	Epidural analgesia was provided with intermittent administrations of 0.08% bupivacaine-epinephrine plus 1 ug/mL of sufentanil. Of the 30 women assigned to the ambulatory group, 25 actually walked. Their ambulating time was 64 ± 34 min (mean±sd), ie, 29 ± 16% of the first stage. There were no differences between the two groups in the length of labor and

			uncomplicated presentation, and 3- to 5-cm cervical dilation at the time of epidural insertion				ability to void, maternal side effects, fetal status at birth		in pain visual analog scale scores. However, the ambulatory group received smaller doses of bupivacaine (6.4 ± 2.2 mg/h versus 8.4 ± 3.6 mg/h; *P*<.01) and of oxytocin (6.0 ± 3.7 mUI/min versus 10.2 ± 8.8 mUI/min; *P*<0.05). A greater ability to void was also found in the ambulatory group (*P*<0.01).
Kariminia 2004	Australia	Randomized controlled trial	Pregnant women at 37 weeks' gestation	Hands and knees position and pelvic rocking exercises from 37 weeks' gestation until the onset of labor	No hands and knees position and pelvic rocking exercises	2,547 women	Incidence of fetal occiput posterior position at birth	Low risk of bias	No significant difference existed between the groups for the incidence of occiput posterior position at birth: 105 (8.1%) women in the intervention group and 98 (7.8%) in the control group had a baby in a posterior position at delivery (difference in risk 0.3%, 95% confidence interval -1.8 to 2.4). The incidence of fetal transverse arrest was 3.4% (44 women) in the intervention group and 3.0% (38 women) in the control group (difference in risk 0.4, -1 to 1.7). No differences occurred between intervention and control groups for induction of labor, use of epidural, duration of labor, mode of delivery, use of episiotomy, or Apgar score.
Benfield 2001	United States	Randomized, pretest-posttest control group design	Parturients at term	Tub of 37C water for 1 hour during early labor (bathers)	Nonbathers	18 parturients	Maternal anxiety, pain during labor	High risk of bias	The Wilcoxon two-sample test revealed statistically significant effects. At 15 min bathers' anxiety and pain scores were decreased compared to nonbathers. At 60 min bathers' pain scores were decreased compared to nonbathers. After 15 min of immersion, bathers had a significantly greater increase in plasma volume than nonbathers. No significant differences were found in urine catecholamines or maternal ± fetal complications.
Garite 2000	United States	Randomized controlled trial	Nulliparous women with uncomplicated singleton gestations at term, in spontaneous active labor with dilatation between 2–5 cm, and with a cephalic presentation	125 mL of intravenous fluids per hour	250 mL of intravenous fluids per hour	195 patients	Mean duration of first stage, mean duration of second stage, mean duration total labor, prolong labor, oxytocin administration for labor augmentation	High risk of bias	The mean volume of total intravenous fluids was significantly greater in the 250-mL group (2,008 mL vs 2,487 mL; *P*=.002), as was the mean hourly rate (152 mL/h in the 125-mL group vs 254 mL/h in the 250-mL group; *P*=.001). The frequency of labor lasting greater than 12 hours was statistically higher in the 125-mL group (20/78 [26%] vs 12/91 [13%]; *P*=.047). In addition, there was a trend favoring longer mean duration of the first stage and total duration of labor in patients delivered vaginally in the 125-mL group, by 70 and 68 minutes, respectively (*P*=.06). There was a trend toward a lower frequency of oxytocin administration for inadequate labor progress in the higher fluid rate group (61 [65%] in the 125-mL group vs 51 [49%] in the 250-mL group; *P*=.06). Cesarean deliveries were more frequent in the 125-mL group (n=16) than in the 250-mL group (n=10) but did not reach statistical significance.
Hickey 2019	United States	Quasiexperimental	Women older than 18 years who received epidural	Peanut ball	Historical group	343 participants	Presence of diabetes, date and time of birth, length of	Moderate risk of bias	Overall, women in the PB group were 50% less likely to have cesarean birth. For women with cervical dilation of 4 cm or less, rates of vaginal birth were 61% with use of the peanut ball. A multivariate analysis of outcomes was used. A multiple

		comparison group	anesthesia, were at least 37 weeks gestation, and had a fetus who was singleton and vertex				Stage 1 labor, length of Stage 2 labor, type of birth (cesarean vs. vaginal), induction, augmentation, gestational age, fetal weight, Apgar scores, dilation/effacement/station at time of epidural placement, time in minutes from one position change to another		linear regression model showed, after adjusting for other variables, that PB placement alone did not shorten labor length (*P*=.4684). However, a stratified analysis indicated that for women with cervical dilation of 4 cm or less, length of the first stage of labor was affected by parity (*P*=.0042) and frequency of position change (*P*<.001). For women with cervical dilation greater than 4 cm, length of the first stage of labor was influenced by frequency of position changes (*P*=.0130) and effacement (*P*=.0050). Length of the second state of labor was affected by the frequency of position change (*P*=.0416).
Meyvis 2012	Belgium	Retrospective cross-sectional	Women with gestations between 37–42 weeks who were delivering vaginally	Lateral maternal position	Lithotomy	557 women	Perineal damage, episiotomy, episiotomy + laceration	Moderate risk of bias	Considering episiotomy as perineal damage, univariate analysis showed a protective effect of the lateral position (45.9% vs 27.9%, *P*>.001), and fewer episiotomies were performed (6.7% vs 38.2%) with this position. This protective effect for perineal damage disappeared on excluding women undergoing episiotomy from analysis. Multivariate analysis including all participants showed an increase of 47 percent in the likelihood of an intact perineum for the lateral position when compared with the lithotomy position (OR: 0.53; 95% CI 0.36–0.78). Parity was associated with a reduction of 44 percent in perineal damage (OR: 0.56; 95% C: 0.47–0.78, *P*<.001). Moreover, the lithotomy position was associated with significantly more episiotomies than the lateral position (7% vs 38%, *P*<.001). The odds of perineal damage increased in deliveries performed by physicians (OR: 2.92; 95% CI 1.79–4.78).
Bodner-Adler 2003	Austria	Case-control	Women with a gestational age greater than 37 weeks, a normal sized fetus and a pregnancy with cephalic presentation	Upright position	Supine position	614 women	Perineal trauma, location of other trauma, episiotomy, infant weight and size, APGAR score, cord pH	Moderate risk of bias	A statistically significant decrease for the use of medical analgesia (*P*=.0001) and oxytocin (*P*=.001) was observed in women using the upright birth position. The length of the first and second stages of labor did not significantly differ between the two groups (*P*>.05). A significantly lower rate of episiotomy was detected in women who delivered in an upright position compared with women delivering supine (*P*=.0001). The frequency of perineal tears, and vaginal and labial trauma did not differ between the two groups (*P*>.05). When analysing maternal blood loss, no significant differences between the

									two groups were found (*P*>.05). No differences in APGAR score less than 7 at 1 and 5 minutes or cord pH less than 7.1 were observed (*P*>.05).
Cervical Examinations									
Myers 2020 (Labor Dystocia AHRQ report)	Global	Systematic review	Women aged 15–44 with uncomplicated pregnancy at 37–42 weeks gestation with a singleton pregnancy with vertex presentation	Regular cervical examinations (timing may vary)	Cervical examination only in the setting of clinical concern about labor progress; regular cervical examinations at differing frequencies	1 SR	Maternal adverse effects, neonatal adverse effects, progress of labor	High quality review	There was insufficient SOE for all outcomes regarding the frequency of cervical examination.
Cahill 2012	United States	Retrospective cohort	Term (37 weeks of gestation or more) singleton deliveries reaching the second stage of labor	Number of digital cervical examinations (intrapartum fever)	Number of digital cervical examinations (afebrile)	2,400 women	Maternal fever, labor and delivery data, neonatal and maternal birth outcomes	Moderate risk of bias	Of 2,395 women who were afebrile at admission, 174 (7.2%) developed an intrapartum fever. Women were examined one to 14 times. There was no significant association between increasing number of examinations and risk of fever. Even for the 505 women who had more than seven examinations during labor, there was no statistically significant increased risk of fever (hazard ratio 0.9, 95% CI 0.4–2.0) compared with those with one to three examinations. Subanalyses by labor type and examinations after rupture of membranes also showed no significant association between number of cervical examinations and risk of intrapartum fever.
Intrauterine Pressure Catheters									
Myers 2020 (Labor Dystocia AHRQ report)	Global	Systematic review	Women aged 15–44 with uncomplicated pregnancy at 37–42 weeks with suspected abnormalities of the first stage of labor	Use of internal pressure catheters for measuring timing and strength of uterine contractions	External tocodynamometry, no monitoring	1 SR	Maternal adverse effects, neonatal adverse effects, progress of labor	High quality review	There were no statistically significant differences between intrauterine pressure catheters and external uterine monitoring for the outcomes of mode of delivery, mean time to delivery, neonatal acidemia, or admission to the NICU (moderate SOE for all outcomes).
Bakker 2013	Global	Systematic review and meta-analysis	Women in induced or augmented labour with oxytocin	Monitoring of contractions with internal tocodynamometry	Monitoring of contractions with external tocodynamometry	3 studies involving a total of 1,945 women	Hyperstimulation, Apgar score less than seven at five	High quality review	Three studies involving a total of 1,945 women were included. Overall, risk of bias across the three trials was mixed. No serious complications were reported in the trials and no neonatal or maternal deaths occurred. The neonatal outcome was not statistically different between groups: Apgar score less than seven at five minutes (RR 1.78, 95% CI 0.83–3.83;

							minutes, umbilical artery pH < 7.15, umbilical artery pH < 7.16, admission to NICU, instrumental vaginal delivery, cesarean section		three studies, n=1,945); umbilical artery pH less than 7.15 (RR 1.31, 95% CI 0.95–1.79; one study, n=1,456); umbilical artery pH less than 7.16 (RR 1.23, 95% CI 0.39–3.92; one study, n=239); admission to the neonatal intensive care unit (RR 0.34, 95% CI 0.07–1.67; two studies, n=489); and more than 48 hours hospitalization (RR 0.92, 95% CI 0.71–1.20; one study, n=1,456). The pooled risk for instrumental delivery (including caesarean section, ventouse and forceps extraction) was not statistically significantly different (RR 1.05, 95% CI 0.91–1.21; three studies, n=1,945). Hyperstimulation was reported in two studies (n = 489), but there was no statistically significant difference between groups (RR 1.21, 95% CI 0.78–1.88).
Mol 2016	Netherlands	Secondary analyses of randomized controlled trial	Women with a singleton pregnancy with a gestational age of more than 36 weeks, a vital fetus in cephalic position, and an indication for either induction or augmentation of labor with intravenous oxytocin	IUP measurement	IUP measurements between groups	503 women	Vaginal instrumental delivery rate, CS rate and adverse neonatal outcome (APGAR score, cord pH, NICU admission)	Moderate risk of bias	Women with lower IUP were statistically significant older, had pregnancies with a longer gestational age, longer labors and neonates with a higher birth weight. The risk of a cesarean section was higher in women who had low IUP during labor (Likelihood Ratio 1.6 for IU<100 MU, 0.41 for IUP>300 MU). IUP was not associated with neonatal outcome
Frey 2014	United States	Case-control	Women in labor with intrauterine pressure catheters (IUPCs) who reached the second stage	Deliver neonates with composite morbidity: special care or intensive care unit admission, umbilical artery pH≤7.1 or 5-min Apgar	Delivered without any components of the composite morbidity	2,355 women	Contraction frequency, duration, relaxation time, Montevideo units (MVUs) and baseline tone in the last 30 min prior to delivery, adverse outcomes	Moderate risk of bias	Contraction duration, relaxation time, MVUs and baseline tone did not significantly differ between the groups. Tachysystole was more common in women with the adverse neonatal outcome (21% versus 15%, *P*=.01). A model including tachysystole, oxytocin use and nulliparity did not adequately predict the adverse outcome (AUC=0.61).
Chin 2012	United States	Retrospective cohort	Women with an intrauterine pressure catheter during the last 2 hours of the first stage of labor and who either had	Prepregnancy BMI category that was defined in the following manner: normal weight (BMI, 25 kg/m^2 or	Between groups	5,410 women	Cesarean delivery, mean MVUs of more than 200 in the last 2 hours of the	Moderate risk of bias	Although obese women were at significantly greater odds of cesarean delivery than normal-weight women (odds ratio, 2.4; 95% CI 1.9–3.1), they were equally able to achieve Montevideo units of 200 or more. Among women with a vaginal delivery, obese women had a longer first stage of labor compared with normal-weight women (597 vs 566 min; *P*=.003).

			a vaginal delivery or cesarean delivery for dystocia	more), overweight (BMI, 26-30 kg/m^2), or obese (BMI, 30 kg/m^2 or more)			first stage of labor		
Bakker 2007	Netherlands	Analysis	Consecutive term singleton, vaginal deliveries	IUP recordings and contraction parameters from deliveries ending with an umbilical artery pH of 7.11 or less	IUP recordings and contraction parameters from deliveries ending with an umbilical artery pH of 7.12 or greater	1,433 deliveries	Fetal outcome	Moderate risk of bias	An umbilical artery pH 7.11 or less at birth is associated with significant more uterine activity during the first and second stage of labor.

Management of Dystocia in the Second Stage of Labor

Author, Year	*Setting*	*Design/ approach*	*Subjects*	*Intervention*	*Comparator*	*Sample size*	*Outcomes*	*Quality Assessment*	*Results*
Pergialiotis 2020	Global	Systematic review and meta-analysis	Women with singleton vertex term gestations	Interventions in second stage of labor	Standard/usual care	13 studies (337,845)	Predisposing factors, mode of delivery, adverse maternal outcomes, adverse neonatal outcomes, duration of second stage, prolonged second stage	Low quality review	Prolonged second stage was associated with higher odds of postpartum hemorrhage, chorioamnionitis, endometritis, postpartum fever and obstetric anal sphincter injury. Persistent occiput posterior position and shoulder dystocia were also more prevalent compared to women with normal duration of the second stage. The need for admission to the neonatal intensive care unit was higher as well as the risk of developing neonatal sepsis. On the other hand, the odds of perinatal death were comparable among cases with prolonged and normal duration of the second stage.
Hofmeyr 2017	Global	Systematic review and meta-analysis	Women with singleton pregnancy in vertex position in second stage of labor	Manual fundal pressure	No fundal pressure	9 trials (3,948 women)	No spontaneous vaginal birth with a specified time, operative birth, low arterial cord pH, Apgar score, duration of active second stage, severe maternal	High quality review	Manual fundal pressure was not associated with changes in: spontaneous vaginal birth within a specified time (risk ratio (RR) 0.96, 95% CI 0.71–1.28; 120 women; 1 trial; very low-quality evidence), instrumental births (RR 3.28, 95% CI 0.14–79.65; 197 women; 1 trial), caesarean births (RR 1.10, 95% CI 0.07–17.27; 197 women; 1 trial), operative birth (average RR 0.66, 95% CI 0.12–3.55; 317 women; 2 studies; I^2=43%; Tau^2=0.71; very low-quality evidence), duration of second stage (mean difference (MD) -0.80 minutes, 95% CI -3.66 to 2.06 minutes; 194 women; 1 study) low arterial cord pH in newborn babies (RR 1.07, 95% CI 0.72–1.58; 297 women; 2

							morbidity or death, neonatal death		trials; very low-quality evidence), or Apgar scores less than seven at five minutes (average RR 4.48, 95% CI 0.28–71.45; 2,759 infants; 4 trials; I^2=89%; Tau^2=3.55. More women who received manual fundal pressure had cervical tears than in the control group (RR 4.90, 95% CI 1.09–21.98; 295 women; 1 trial). No neonatal deaths occurred in either of the two studies reporting this outcome. No trial reported the outcome severe maternal morbidity or death. Fundal pressure by inflatable belt did not reduce the number of women having instrumental births (average RR 0.73, 95% CI 0.52–1.02; 891 women; 4 trials; I^2=52%; Tau^2=0.05) or operative births (average RR 0.62, 95% CI 0.38–1.01; 891 women; 4 trials; I^2=78%; Tau^2=0.14; very low-quality evidence). Heterogeneity was high for both outcomes. Duration of second stage was reported in two trials, which both showed that inflatable belts shortened duration of labor in nulliparous women (average MD -50.80 minutes, 95% CI -94.85 to -6.74 minutes; 253 women; 2 trials; I^2=97%; Tau^2=975.94). No data on this outcome were available for multiparous women. The inflatable belt did not make any difference to rates of caesarean births (average RR 0.56, 95% CI 0.14–2.26; 891 women; 4 trials; I^2=70%; Tau^2=0.98), low arterial cord pH in newborn babies (RR 0.47, 95% CI 0.09–2.55; 461 infants; 1 trial), or Apgar scores less than seven at five minutes (RR 4.62, 95% CI 0.22–95.68; 500 infants; 1 trial). Third degree perineal tears were increased in the inflatable belt group (RR 15.69, 95% CI 2.10–117.02; 500 women; 1 trial). Spontaneous vaginal birth within a specified time, neonatal death, and severe maternal morbidity or death were not reported in any trial.
Altman 2006	Global	Systematic review	Singleton infants with cephalic presentation (differing gestation periods)	Duration of second stage (varied between studies)	Differing time from intervention (varied between studies)	8 studies (58,828 participants)	Method of delivery, postpartum hemorrhage, infection, severe obstetric lacerations, postpartum voiding difficulty, Apgar scores, umbilical artery pH, NICU admission	Critically low-quality review	Although significant associations with maternal outcomes such as postpartum hemorrhage, infection, and severe obstetric lacerations were reported, inherent limitations in methodology were evident in the studies. Recurrent limitations included oversimplified categorization of second stage, inconsistency in study population characteristics, and lack of control of confounding factors. No associations between prolonged second stage and adverse neonatal outcomes were reported
Athukorala 2006	Global	Systematic review and meta-analysis	Women with term, cephalic singleton gestations including those determined by the	McRobert’s manoeuvre; positioning of mother	Application of suprapubic pressure	2 trials (225 women)	Incidence of should dystocia, severity of shoulder dystocia, fetal outcomes,	High quality review	Two trials were included; one comparing the McRobert's manoeuvre and suprapubic pressure with no prophylactic manoeuvres in 185 women likely to give birth to a large baby and one trial comparing the use of the McRobert's maneuver versus lithotomy positioning in 40 women. We decided not to pool the results of the two trials. One study reported 15 cases

			authors as being at risk for shoulder dystocia				maternal outcomes, mode of birth, use of health services		of shoulder dystocia in the therapeutic (control) group compared to five in the prophylactic group (risk ratio (RR) 0.44, 95% confidence interval (CI) 0.17–1.14) and the other study reported one episode of shoulder dystocia in both prophylactic and lithotomy groups. In the first study, there were significantly more caesarean sections in the prophylactic group and when these were included in the results, significantly fewer instances of shoulder dystocia were seen in the prophylactic group (RR 0.33, 95% CI 0.12–0.86). In this study, 13 women in the control group required therapeutic maneuvers after delivery of the fetal head compared to three in the treatment group (RR 0.31, 95% CI 0.09–1.02). One study reported no birth injuries or low Apgar scores recorded. In the other study, one infant in the control group had a brachial plexus injury (RR 0.44, 95% CI 0.02–10.61), and one infant had a five-minute Apgar score less than seven (RR 0.44, 95% CI 0.02–10.61).
De Jonge 2004	Global	Systematic review and meta-analysis	Women in the second stage of labor who were expected to have a vaginal birth	Supine position	Other position	10 studies	Instrumental delivery, postpartum hemorrhage, blood transfusion, episiotomy, second degree tear, abnormal fetal heart pattern, Apgar score, mean artery pH, neonatal resuscitation	Moderate quality review	A meta-analysis indicated a higher rate of instrumental deliveries and episiotomies in the supine position. A lower estimated blood loss and lower rate of postpartum hemorrhage were found in the supine position; however, it is not clear whether this is a real or only an observed difference. Heterogenous, non-pooled data showed that women experienced more severe pain in the supine position and had a preference for other birthing positions.
Frolova 2019	United States	Secondary analysis of a prospective cohort	Nulliparous women who presented for labor at term and reached complete cervical dilation	Obese	Non-obese	2,948 women	Prolonged second stage duration, second stage cesarean delivery, composite neonatal and maternal morbidity	Moderate risk of bias	Compared with nonobese, obese women were more likely to have a prolonged second stage (aRR: 1.48, 95% CI 1.18–1.85 for 3 hours or more; aRR: 1.65, 95% CI 1.18–2.30 for 4 hours or more). Obesity was associated with a higher rate of second stage cesarean (aRR: 1.78, 95% CI 1.34–2.34) and cesarean delivery for fetal distress (aRR: 2.67, 95% CI 1.18–3.58). Obesity was also associated with increased rates of neonatal (aRR: 1.38, 95% CI 1.05–1.80), but not maternal morbidity (aRR: 1.06, 95% CI 0.90–1.25). Neonatal morbidity risk was not modified by prolonged second stage.
Zipori 2019	Israel	Retrospective, single center cohort	Women with singleton deliveries at or beyond 37 weeks' gestation	Duration of the second stage of labor	Compared between time periods	19,831 women	Early neonatal outcome, including umbilical artery cord pH and base excess, and early	Moderate risk of bias	The primary cesarean delivery was decreased in nulliparous women from 23.3% (819 of 3,515) in period I to 15.7% (596 of 3,796) in period II (relative risk [RR], 0.67; 95% CI 0.61–0.74), a trend that was also significant in multiparous women (10.9%, 623 of 5,785, in period I vs 8.1%, 544 of 6,735, in period II; RR, 0.75; 95% CI 0.67–0.84). The rate of operative vaginal deliveries in nulliparous women was higher in period

							neurological outcome, other maternal and fetal parameters		II than in period I (19.2%, 732 of 3,515, vs 17.7%, 622 of 3,796, *P*<.0001). Rates of third- and fourth-degree laceration and of shoulder dystocia were also higher in period II. The rate of arterial cord pH less than 7.0 and the rate of admission to the neonatal intensive care unit were higher in period II, but the early neurological outcome was not different when comparing the two periods.
Morcos 2018	United States	Retrospective cohort	Nulliparous women with singleton gestations at 36–0/7 weeks gestation or greater	Passive descent was defined as 60 min or more of nonactive second stage	No passive descent was defined as less than 60 min of nonactive second stage	872 nulliparas	Presence of passive descent, length of the second stage, mode of delivery, chorioamnionitis, postpartum hemorrhage	Moderate risk of bias	Passive descent was observed in 198 women in the second stage. When passive descent occurred, the differences in the median length of the second stage in relation to the nursing shift increments were statistically significant, with the longest times corresponding to the middle 4 hours of the nursing shifts (*P*=.046). Physician patients were more likely than midwife patients to undergo passive descent on weekdays (36% vs. 26%, *P*=.034) but not on weekends (32% for both). Though the likelihood of a vaginal delivery remained high up to 6 hours into the second stage, the rate of hemorrhage and chorioamnionitis increased significantly.
Duckelmann 2012	Germany	Retrospective cohort	Women with fetuses in cephalic presentation, who were diagnosed with a prolonged second stage of labor	Intrapartal ultrasound prior to obstetrical intervention	Clinical digital examination alone	121 women	Blood loss, the degree of perineal laceration, other adverse events, fetal well-being, umbilical artery pH, pH on the newborn, the frequency of a 5-min Apgar score of less than 7, admission to the NICU, cephalohematoma, neonatal death	Serious risk of bias	There were no significant differences in maternal and neonatal morbidity between both groups. The rate of second-stage cesarean section was significantly higher (*P*<.50) in Group B without ultrasound compared to Group A with ultrasound prior to operative delivery (20/78 vs. 7/43). Seven patients in Group A delivered spontaneously, but none of the patients in Group B had spontaneous deliveries.
Lu 2009	United States	Retrospective case–control	Women with postpartum hemorrhage (PPH)	Postpartum hemorrhage (PPH)	Non-cases	414 women	Mean duration of labor, prolonged labor for each stage of labor	Moderate risk of bias	Cases were significantly more likely than controls to have had a prolonged second stage of labor, over a range of definitions for PPH and prolonged second stage. In multivariable analyses, prolonged second stage was associated with greater than three-fold (OR=3.35; 95% CI 1.22–9.19) increased risk for PPH.
Rouse 2009	United States	Secondary analysis of a clinical trial	Nulliparous women who were carrying a singleton vertex fetus and who	Fetal pulse oximetry	n/a	5,341 participants	Duration of labor, use of oxytocin, use of epidural analgesia, type of	Moderate risk of bias	4,126 women reached the second stage of labor. As the duration of the second stage increased, spontaneous vaginal delivery rates declined, from 85% when the duration was less than 1 hour to 9% when it was 5 hours or later. Adverse maternal outcomes that were associated significantly with the

			labored spontaneously or were induced at 36 weeks gestation or later and reached second stage of labor				delivery, maternal morbidities, neonatal composite		duration of the second stage of labor included chorioamnionitis (overall rate, 3.9%), third- or fourth-degree perineal laceration (overall rate, 8.7%), and uterine atony (overall rate, 3.9%). Odds ratios for each additional hour of the second stage of labor ranged from 1.3–1.8. Among individual adverse neonatal outcomes, only admission to a neonatal intensive care unit was associated significantly with second stage duration (odds ratio, 1.4).
Sheiner 2006	Israel	Prospective observational	Patients at 37–42 weeks of singleton gestation who presented in active labor	Interview	n/a	300 women	Perineal damage/perineal lacerations	Serious risk of bias	139 were primiparas. Episiotomy was performed in 32% of the population (62% in primiparas, 6% in multiparas). Spontaneous perineal tears requiring suturing occurred in 28%. Severe perineal tears (grades 3 and 4) occurred in 1%. Risk factors for adverse perineal outcome in the non-episiotomy group included younger maternal age, non-Israeli ethnic background, use of epidural analgesia, nulliparity, shorter interval since last vaginal delivery, longer active phase and prolonged second stage. Prolonged second stage (more than 40 minutes) and low parity were independent risk factors for perineal tears in a multivariable analysis.
Senecal 2005	United States	Retrospective cohort	Nulliparous women age 18 years or older, gestational age 37 weeks or more, single fetus in cephalic presentation, normal fetal heart rate pattern status, effective epidural analgesia using a standardized continuous infusion technique and full dilatation	Position of fetus (posterior, transverse, anterior)	Between groups	1,608 women	Mode of delivery, oxytocin before full dilatation, episiotomy, perineal tear, estimated blood loss, postpartum fever, Apgar score, abnormal fetal pH, NICU admission, neonatal trauma, duration of second stage of labor	Moderate risk of bias	Fetal malposition at full dilatation was associated with a significantly increased risk of instrumental vaginal delivery, cesarean delivery, oxytocin administration before full cervical dilatation, episiotomy, severe perineal laceration, and maternal blood loss of more than 500 mL (all *P* values less than .01). Compared with the occiput anterior positions, there were significant differences in the duration of the second stage of labor, with a mean of 3.1 hours (95% CI 3.0 –3.2) for occiput anterior positions, 3.6 hours (95% CI 3.3–3.9) for occiput transverse positions (*P*<.05), and 3.8 hours (95% CI 3.5–4.1) for occiput posterior positions (*P*<.05) in the delayed pushing group. For the early pushing group, means were 2.2 hours (95% CI 2.1–2.3) for occiput anterior positions, 2.5 hours (95% CI 2.3–2.8) for occiput transverse positions (*P*<.05), and 3.0 hours (95% CI 2.7–3.3) for occiput posterior positions (*P*<.05).
Myles 2003	United States	Retrospective review and analysis	Hospital patients	Duration of second stage of labor by group	Between groups	7,818 patients	Maternal and neonatal morbidity factors	Moderate risk of bias	Vaginal delivery rates were 98.7% (group 1), 84.0% (group 2), 90.2% (group 2A), and 65.5% (group 2B). Group 2 had higher rates of perineal trauma, episiotomy usage, chorioamnionitis, postpartum hemorrhage, and operative vaginal delivery than group 1 (*P*<.001, all comparisons). Group 2B had higher rates of episiotomy usage, operative vaginal deliveries, and perineal trauma than group 2A (*P*<.001, all comparisons). The neonatal morbidity rates were similar for the three groups. Diabetes, preeclampsia (*P*<.023), macrosomia, nulliparity, chorioamnionitis, oxytocin usage, and labor induction

									were each independently associated with an increased risk of a prolonged second stage (all but preeclampsia, *P*<.001).
Janni 2002	Germany	Analysis	Patients delivered of a singleton fetus in cephalic presentation beyond the 34th week of gestation	Vaginal examinations after regular periods of time, labor intervention(s)	n/a	1,457 patients	Second stage duration, severe pelvic floor damage, maternal hemorrhage, maternal fever, delayed involution of the uterus, fetal acidosis and APGAR score, the necessity for admitting the newborn to the NICU	Moderate risk of bias	The mean duration of the second stage of labor was 70min (range 2–387, SD 73 min). For 952 patients (79.3%), the second stage was less than 2 hours. For 47 patients (3.9%), it exceeded 4 hours. A prolonged duration of the second stage was not associated with low Apgar scores 5 and 10min postpartum (*P*=0.76 and *P*=0.38, respectively), a higher incidence of umbilical artery pH levels of 7.20 (*P*=0.60), nor with an increased rate of admission to the NICU (*P*=0.24). A significant increase in the rate of maternal blood loss was noted after long second stages (1.84 g/dl median difference between the intrapartum and postpartum hemoglobin level) in comparison to patients with normal duration of second stage (0.79 g/dl), both by univariate (*P*<.0001) and multivariate (*P*<.001) analysis. The incidence of third degree anal sphincter tears was significantly correlated with a prolonged duration of second stage in univariate analysis (7.7%, *P*=.001), but not in multivariate analysis after allowing for duration of the second stage, maternal age, birth weight, episiotomy, and mode of delivery (*P*=.26).
Delayed or Immediate Pushing									
Myers 2020 (Labor Dystocia AHRQ report)	Global	Systematic review	Women aged 15-44 with uncomplicated pregnancies at 37-42 weeks who have reached complete cervical dilation	Immediate pushing upon complete dilatation	Other specified maternal techniques/approaches to pushing	6 articles	Maternal adverse effects, neonatal adverse effects, progress of labor	High quality review	Valsalva/coached and spontaneous/uncoached pushing have similar rates of cesarean delivery (low SOE). There is limited evidence that immediate pushing has a shorter labor duration when compared to delayed pushing in nulliparous women (low SOE). There was limited evidence of no difference in neonatal outcomes for immediate versus delayed pushing (low SOE).
Lemos 2017	Global	Systematic review and meta-analysis	Women in the second stage of labour	Comparison 1: spontaneous pushing; Comparison 2: delayed pushing	Comparison 1: directed pushing; Comparison 2: immediate pushing	21 studies (884 women)	Duration of second stage, perineal lacerations, admission to NICU, hypoxic ischaemic encephalopathy, Apgar score, duration of pushing, spontaneous vaginal delivery	High quality review	Comparison 1: types of pushing: spontaneous pushing versus directed pushing: There was no clear difference in the duration of the second stage of labour (mean difference (MD) 10.26 minutes; 95% confidence interval (CI) -1.12 to 21.64 minutes, six studies, 667 women, random-effects, IS=81%). There was no clear difference in 3rd or 4th degree perineal laceration (risk ratio (RR) 0.87; 95% CI 0.45–1.66, one study, 320 women), episiotomy (average RR 1.05; 95% CI 0.60–1.85, two studies, 420 women, random-effects, IS=81%), duration of pushing (MD -9.76 minutes, 95% CI -19.54 to 0.02; two studies; 169 women; IS=88%), or rate of spontaneous vaginal delivery (RR 1.01, 95% CI 0.97–1.05; five studies; 688 women; IS=2%). For primary neonatal outcomes such as five-minute Apgar score less than seven, there was no clear

									difference between groups (RR 0.35; 95% CI 0.01–8.43, one study, 320 infants), and the number of admissions to neonatal intensive care (RR 1.08; 95% CI 0.30–3.79, two studies, 393 infants) also showed no clear difference between spontaneous and directed pushing. No data were available on hypoxic ischaemic encephalopathy. Comparison 2: timing of pushing: delayed pushing versus immediate pushing (all women with epidural) For the primary maternal outcomes, delayed pushing was associated with an increase of 56 minutes in the duration of the second stage of labour (MD 56.40, 95% CI 42.05–70.76; 11 studies; 3,049 women; IS=91%), but no clear difference in third or 4th degree perineal laceration (RR 0.94; 95% CI 0.78–1.14, seven studies. 2,775 women) or episiotomy (RR 0.95; 95% CI 0.87–1.04, five studies, 2,320 women). Delayed pushing was also associated with a 19-minute decrease in the duration of pushing (MD -19.05, 95% CI -32.27 to -5.83; 11 studies; 2,932 women; IS=95%) and an increase in spontaneous vaginal delivery (RR 1.07; 95% CI 1.02–1.11, 12 studies, 3,114 women). For the primary neonatal outcomes, there was no clear difference between groups in admission to neonatal intensive care (RR 0.98; 95% CI 0.67–1.41, three studies, n=2,197) and five-minute Apgar score less than seven (RR 0.15; 95% CI 0.01–3.00; three studies; 413 infants). There were no data on hypoxic ischaemic encephalopathy. Delayed pushing was associated with a greater incidence of low umbilical cord blood pH (RR 2.24; 95% CI 1.37–3.68, 4 studies, 2,145 infants) and increased the cost of intrapartum care by CDN$ 68.22 (MD 68.22, 95% CI 55.37–81.07, one study, 1,862 women).
Tuuli 2012	Global	Systematic review and meta-analysis	Multiparous and primiparous women	Immediate pushing	Delayed pushing	12 RCTs (3,115 women)	Spontaneous vaginal delivery, instrumental delivery, cesarean delivery, duration of the second stage, duration of active pushing, other maternal and neonatal outcomes	High quality review	Overall, delayed pushing was associated with an increased rate of spontaneous vaginal delivery compared with immediate pushing (61.5% compared with 56.9%, pooled RR 1.09, 95% confidence interval [CI] 1.03–1.15). This increase was smaller and not statistically significant among high-quality studies (59.0% compared with 54.9%, pooled RR 1.07, 95% CI 0.98–1.26) but larger and statistically significant in lower quality studies (81.0% compared with 71.0%%, pooled RR 1.13, 95% CI 1.02–1.24). Operative vaginal delivery rates were high in most studies and not significantly different between the two groups (33.7% compared with 37.4%, pooled RR 0.89, 95% CI 0.76–1.06). Delayed pushing was associated with prolongation of the second stage (weighted mean difference 56.92 minutes, 95% CI 42.19–71.64) and shortened duration of active pushing (weighted mean difference -21.98 minutes, 95% CI -31.29 to -12.68).

Prins 2011	Global	Systematic review and meta-analysis	Primparous women in second stage of labour	Instructed pushing	Spontaneous pushing	3 RCTs (425 women)	Instrumental/operative delivery, length of labour, any perineal repair, bladder function, maternal satisfaction, Apgar score, umbilical arterial pH, admission to NICU, serious neonatal morbidity or perinatal death	High quality review	Women who used epidural analgesia were excluded in all three studies. No statistical difference was identified in the number of instrumental/operative deliveries (three studies; 425 women; relative risk 0.70; 95% CI 0.34–1.43), perineal repair, postpartum haemorrhage. Length of labour was significantly shorter in women who used the Valsalva pushing technique (three studies; 425 women; mean difference 18.59 minutes; 95% CI 0.46–36.73 minutes). Neonatal outcomes did not differ significantly. Urodynamic factors measured 3 months postpartum were negatively affected by Valsalva pushing. Measures of first urge to void and bladder capacity were decreased (one study; 128 women; mean difference respectively 41.50 ml, 95% CI 8.40–74.60, and 54.60 ml, 95% CI 13.31–95.89).
Bellussi 2018	Italy	Randomized controlled trial	Low-risk nulliparous women in the active second stage of labor	Coached pushing aided by visual demonstration on transperineal ultrasound of the progress of the fetal head (sonographic coaching)	Traditional coaching	40 women	Duration of the active second stage, increase in the angle of progression at the end of the coaching process, incidence of operative delivery, complications of labor	High risk of bias	Those who received sonographic coaching had a shorter active phase of the second stage (30 min (interquartile range (IQR), 24–42 min) vs 45 min (IQR, 39–55 min); *P*=.01) and a greater increase in the angle of progression (13.5 (IQR, 9–20) vs 5 (IQR, 3–9.5); *P*=.01) in the first 20 min of the active second stage of labor than did those who had traditional coaching. No differences were found in the secondary outcomes between the two groups.
Cahill 2018	United States	Randomized controlled trial	Nulliparous women at or beyond 37 weeks' gestation admitted for spontaneous or induced labor with neuraxial analgesia	Immediate group	Delayed group	2,404 participants	Spontaneous vaginal delivery, duration of the second stage, duration of active pushing, operative vaginal delivery, cesarean delivery, postpartum hemorrhage, chorioamnionitis, endometritis, perineal lacerations,a composite outcome of neonatal morbidity that included neonatal	Low risk of bias	The rate of spontaneous vaginal delivery was 85.9% in the immediate group vs 86.5% in the delayed group, and was not significantly different (absolute difference, -0.6% [95% CI,-3.4% to 2.1%]; relative risk,0.99 [95% CI, 0.96–1.03]). There was no significant difference in 5 of the 9 prespecified secondary outcomes reported, including the composite outcome of neonatal morbidity (7.3% for the immediate group vs 8.9% for the delayed group; between-group difference, -1.6% [95% CI, -3.8% to 0.5%]) and perineal lacerations (45.9% vs 46.4%, respectively; between-group difference, -0.4% [95% CI,-4.4% to 3.6%]).The immediate group had significantly shorter mean duration of the second stage compared with the delayed group (102.4 vs 134.2 minutes, respectively; mean difference, -31.8 minutes [95% CI -36.7 to -26.9], *P*<.001), despite a significantly longer mean duration of active pushing (83.7 vs 74.5 minutes; mean difference, 9.2 minutes [95% CI 5.8–12.6], *P*<.001), lower rates of chorioamnionitis (6.7% vs 9.1%; between-group difference, -2.5% [95% CI, -4.6% to -0.3%], *P*=.005), and fewer postpartum hemorrhages (2.3% vs

							death and 9 other adverse outcomes		4.0%; between-group difference, -1.7% [95% CI, −3.1% to −0.4%], *P*=.03).
Moraloglu 2017	Turkey	Randomized controlled trial	Nulliparous women in second stage labor	Squatting position using bars	Supine position modified to 45 degree of semi-fowler	102 women	Duration of the second stage of labor, maternal pain, postpartum blood loss, abnormal fetal heart rate patterns that required intervention, newborn outcomes	High risk of bias	The trial showed that women who adopted the squatting position using bars experienced a significant reduction in the duration of the second stage of labor; they were less likely to be induced, and their Visual Analog Scale score was lower than those who were allocated the supine position modified to 45 degree of semi-fowler during second stage of labor (*P*<.05). There were no significant differences with regard to postpartum blood loss, neonatal birth weight, Apgar score at one and five minutes, or admission to the Neonatal Intensive Care Unit.
Gillesby 2010	United States	Randomized controlled trial	Nulliparous laboring women with epidural anesthesia	Immediate pushing	Delayed pushing	77 women	Length of pushing, total length of the second stage, maternal fatigue	High risk of bias	The immediate pushing group averaged 94 (± 57) minutes in active pushing, while the delayed pushing group averaged 68 (± 46) minutes, a statistically significant difference (*P*=.04). No significant differences were found in fatigue scores between the immediate and delayed pushing groups (*P*>.05).
Bloom 2006	United States	Randomized controlled trial	Nulliparous women with uncomplicated labors and without epidural analgesia	Coached pushing	Uncoached pushing	320 women	Length of second stage, route of delivery, episiotomy, perineal laceration, shoulder dystocia, Apgar score, umbilical artery pH, meconium-stained fluid, delivery room resuscitation, sepsis workup, NICU admission, stillbirth or neonatal death	Low risk of bias	The second stage of labor was abbreviated by approximately 13 minutes in coached women (*P*=.01). There were no other clinically significant immediate maternal or neonatal outcomes between the 2 groups.
Plunkett 2003	United States	Randomized controlled trial	Nulliparas with standardized patient-controlled epidural analgesia	Pushing immediately	Waiting for strong urge to push	202 women	Duration of pushing, total duration	High risk of bias	Women who delayed pushing and those who pushed immediately were similar with respect to maternal characteristics. Women who delayed pushing had a stronger urge to push (*P*<.01) and a longer second stage (*P*<.05) than women who pushed immediately. There was no significant difference in the time spent pushing (median 57 versus 62 minutes, respectively) or the median level of patient satisfaction (80 mm for both groups). There were no significant differences in the overall rates of cesarean delivery (6% versus 12%,

									respectively), cesarean delivery during the second stage (2% in each group), spontaneous vaginal delivery (70% versus 69%, respectively), or neonatal or maternal morbidity.
Fitzpatrick 2002	Ireland	Randomized controlled trial	Nulliparous women at full dilatation	Immediate pushing	Delayed pushing	170 women	Mode of delivery, altered faecal continence	Unclear/low risk of bias	The spontaneous delivery rate was 56% (50/90) in the immediate pushing group and 52% (46/88) in the delayed pushing group. Mean duration of labour for the immediate pushing group was 427 minutes compared with 480 minutes for the delayed pushing group (*P*=.005). Eighty-four percent (76/90) of women in the immediate pushing group received oxytocin to augment labour, 21/76 (28%) in the second stage only. Eighty-one percent (71/88) of women in the delayed pushing group received oxytocin to augment labour, 22/71 (31%) in the second stage only. Fetal outcome did not differ between the two groups. Episiotomy rates were 73% and 69% in the immediate pushing and delayed pushing groups, respectively. 26% (23/90) of the immediate pushing group and 38% (33/88) of the delayed pushing group complained of altered faecal continence after delivery (NS). Manometry, ultrasound and neurophysiology studies did not differ significantly between the two groups. Overall, 55% of women after instrumental delivery had endosonographic evidence of damage to the external anal sphincter, while 36% of women after spontaneous delivery had abnormal neurophysiology studies.
Hansen 2002	United States	Randomized controlled trial	Women with epidural anesthesia	Rest period	Immediate pushing	252 women	Rate of fetal descent, length of time of pushing, the number and type of fetal heart rate decelerations, Apgar scores, arterial cord pH values, perineal injuries, type of delivery, length of second stage, maternal fatigue, endometritis	High risk of bias	When a period of rest was used before pushing, we found a longer second stage, decreased pushing time, fewer decelerations, and, in primiparous women, less fatigue compared with control patients. Apgar scores, arterial cord pH values, rates of perineal injury, instrument delivery, and endometritis were similar in both groups.
Fraser 2000	Canada	Randomized controlled trial	Nulliparous women with continuous-infusion epidural analgesia	Delayed pushing	Early pushing	1,862 women	Difficult delivery, spontaneous vaginal delivery, perineal or cervical tears, estimated blood	High risk of bias	Difficult delivery was reduced with delayed pushing (relative risk, 0.79; 95% CI 0.66–0.95). The greatest effect was on midpelvic procedures (relative risk, 0.72; 95% CI 0.55–0.93). Although there was little evidence for an effect on low-pelvic procedures, spontaneous delivery was more frequent among women who practiced delayed pushing (relative risk, 1.09; 95% CI 1.00–1.18). Abnormal umbilical cord blood pH (<7.15

							loss >500 mL, requirement for blood transfusion, intrapartum and postpartum febrile morbidity, antibiotic administration		venous value or <7.10 arterial value) was more frequent in the delayed pushing group (relative risk, 2.45, 95% CI 1.35–4.43). However, scores for a summary indicator, the Neonatal Morbidity Index, were similarly distributed in the 2 groups.
Kahrs 2019	Norway, United Kingdom, Italy, Iceland, Denmark	Secondary analysis of prospective cohort	Nulliparous women with prolonged second stage of labor	Ultrasound examination after at least 45 min of pushing	n/a	204 women	Duration of operative vaginal Delivery, mode of delivery, neonatal outcome	Moderate risk of bias	Duration of vacuum extraction was shorter with increasing delta HPD. Estimated mean duration was 10.0, 9.0, 8.8 and 7.5 min in pregnancies with delta HPD in the first to fourth quartiles, respectively, and the adjusted HR for vaginal delivery, using increasing delta HPD as a continuous variable, was 1.04 (95% CI 1.01–1.08). Mean delta HPD was 7mm (range, -10 to 37 mm). Delta HPD was either negative or ≤2mm in the lowest quartile. In this group, 7/50 (14%) pregnancies were delivered by Cesarean section, compared with 8/154 (5%) of those with delta HPD >2mm (*P*<0.05). There was no significant association between umbilical artery pH<7.10 or 5-min Apgar score<7 and delta HPD quartile.
Lee 2019	Australia	Retrospective cross-sectional	Term women with singleton, cephalic presentation experiencing a non-operative vaginal birth without regional analgesia	Spontaneous pushing	Directed pushing	19,212 participants	Duration of second stage labour, severe perineal injury, episiotomy use, need for active resuscitation, admission to intensive care nursery, Apgar score	Serious risk of bias	Directed pushing was associated with a longer duration of second stage labour for nulliparous (mean 14.4 min [12.0–16.8]) and multiparous (mean 8.0 min [6.8–9.2]) women, and an increased risk of prolonged 2nd stage of labour in multiparous women. The use of episiotomy in the directed pushing group was significantly higher both prior to and following PS matching and adjustment. Directed pushing was also associated with a significantly increased risk of neonatal resuscitation and nursery admission. There was no difference in rates of Apgar <7 recorded at 5 min of age.
Yee 2016	United States	Secondary analysis of observational study	Nulliparous women with singleton, cephalic, nonanomalous term births who achieved 10 cm cervical dilation	Pushing was delayed by ≥60 minutes (delayed group)	Initiated pushing within 30 minutes (early group)	21,034 women	Mode of delivery, length of second stage and other maternal and perinatal outcomes	Moderate risk of bias	Women who were older, privately insured, or non-Hispanic white, as well as those who had induction or augmentation of labor, diabetes, or epidural analgesia were more likely to have delayed pushing. Delayed pushing was more common when the second stage began during daytime hours or in hospitals with dedicated 24-hour obstetric anesthesia, although differences were small. After adjusting for differences in baseline and labor characteristics including center, women in the delayed group had longer mean durations of the second stage (191 vs. 84 min, *P*<.001) and of active pushing (86 vs. 76 min, *P*<.001). Delayed pushing was associated with greater rates of cesarean delivery (11.2% vs 5.1%; adjusted odds ratio [aOR] 1.86, 95% CI 1.63–2.12), operative vaginal delivery (aOR 1.26, 95% CI 1.14–1.40), postpartum

									hemorrhage (aOR 1.43, 95% CI 1.05–1.95) and blood transfusion (aOR 1.51, 95% CI 1.04–2.17). Delayed pushing was not associated with increased odds of adverse neonatal outcomes compared with early pushing.
Frey 2012	United States	Retrospective cohort	Women in labor at term who reached the second stage of labor	Delayed pushing	Immediate pushing	5.290 women	Mode of delivery	Moderate risk of bias	471 (8.9%) employed delayed pushing, and 4,819 (91.1%) pushed immediately. Delayed pushing was associated with increased rates of cesarean, operative vaginal delivery, maternal fever, and lower arterial cord pH. Duration of the second stage and length of time spent pushing were significantly longer with delayed pushing.
Park 2012	United States	Retrospective cohort	Women with a body mass index (BMI) of 40 or greater admitted for term labor that reached the second stage of labor	Immediate pushing group, defined as those women who initiated active pushing within 30 minutes of start of the second stage	Passive descent group, defined as those women who had delayed active pushing until at least 30 minutes after documentation of complete dilation	558 women	Labor outcomes, maternal and neonatal outcomes, length of second stage of labor	Moderate risk of bias	97 underwent passive descent and 461 pushed immediately. Morbidly obese women selected for passive descent were just as likely to actively push for at least 60 minutes compared with those who pushed immediately (16.5% compared with 7.2%, adjusted odds ratio [OR] 1.51, 95% confidence interval [CI] 0.74–3.12). They were also significantly more likely to push for more than 30 minutes (37.1% compared with 13.9%, adjusted OR 2.03, 95% CI 1.17–3.54). Their overall time (minutes) spent pushing was significantly longer (median 19, interquartile range 7–39 compared with median 7, interquartile range 3–17, *P*<.001) as was their overall length of second stage (median 81, interquartile range 57–127 compared with median 15, interquartile range 8–27, *P*<.001). They had similar rates of operative delivery and maternal febrile morbidity.
LeRay 2009	France	Secondary analysis of randomized controlled trial	Nulliparous women with epidural analgesia who were in the second stage of labor	Early pushing	Late pushing	1,862 women	Spontaneous vaginal delivery of an infant with no signs of asphyxia	Serious risk of bias	Relative to the first hour of expulsive efforts, the chances of a spontaneous vaginal delivery (SVD) of a newborn infant without signs of asphyxia decreased significantly every hour (1- to 2-hour adjusted odds ratio, 0.4; 95% confidence interval [CI] 0.3–0.6; 2- to 3-hour adjusted odds ratio, 0.1; 95% CI 0.09–0.2; 3-hour adjusted odds ratio, 0.03; 95% CI 0.02–0.05). The risk of postpartum hemorrhage and intrapartum fever increased significantly after 2 hours of pushing.
Sampselle 2005	United States	Secondary analysis	Primigravidas who gave birth vaginally	Provider communication supportive of spontaneous pushing	Provider communication supportive of directed pushing	20 primigravidas	Maternal pushing behavior (spontaneous or directed)	Serious risk of bias	The percentage of provider communication supporting spontaneous pushing versus directed pushing and the percentage of actual spontaneous versus directed maternal pushing behavior were associated (Pearson r=.80, *P*=.001, for spontaneous and r=.89, *P*=.001, for directed). Neither duration of second stage (t=.06, *P*=.95) nor time spent pushing (t=.15, *P*=.89) differed by spontaneous versus directed pushing style.
Manual Rotation									
Bertholdt, 2022	France	Systematic review and	Women with singleton pregnancies at ≥37	Manual rotation	Control group	7 studies (1,402 women)	Spontaneous vaginal delivery	Moderate	Manual rotation increased the rate of spontaneous vaginal delivery.

		meta-analysis	weeks of gestation					quality review	
Phipps 2014	Global	Systematic review and meta-analysis	Women at term planning a vaginal birth with a cephalic singleton fetal malposition in labour	Prophylactic manual rotation	Expectant management, augmentation of labour or operative delivery	1 study involving 30 women	Operative delivery (forceps or vacuum delivery or caesarean section), maternal mortality, perinatal mortality	Moderate quality review	Only one small pilot study involving 30 women was found that assessed the feasibility of manual rotation versus routine care (no manual rotation). The study reported no clear difference for the review's primary outcomes of operative delivery (vacuum-assisted delivery or forceps delivery (or both), or caesarean section) and no mother or baby deaths. In terms of adverse events, there were no reported cases of umbilical cord prolapse or cervical laceration and a single case of a non-reassuring or pathological cardiotocograph during the procedure. Further research is needed to assess the effect of manual rotation in second stage of labour to reduce operative delivery rates.
de Vries 2022	Australia	Randomized controlled trial	Women who are at ≥37 weeks' gestation with a baby in the occiput transverse position early in the second stage of labor	Prophylactic manual rotation	Sham procedure	160 women	Operative (cesarean, forceps, or vacuum) delivery	Low risk of bias	Operative delivery occurred in 41 of 80 women (51%) assigned to prophylactic manual rotation and 40 of 80 women (50%) assigned to a sham rotation (common risk difference, -4.2% [favors sham rotation]; 95% CI -21 to 13; *P*=.63). Among more experienced proceduralists, operative delivery occurred in 24 of 47 women (51%) assigned to manual rotation and 29 of 46 women (63%) assigned to a sham rotation (common risk difference, 11%; 95% CI -11 to 33; *P*=.33). Cesarean delivery occurred in 6 of 80 women (7.5%) in the manual rotation group and 7 of 80 women (8.7%) in the sham group. Instrumental (forceps or vacuum) delivery occurred in 35 of 80 women (44%) in the manual rotation group and 33 of 80 women (41%) in the sham group. There was no significant difference in the combined maternal and perinatal outcomes. The trial was terminated early because of limited resources.
Bueno Lopez 2018	Spain	Randomized controlled trial	Women in labor with fetuses in persistent occiput posterior (POP) position	Modified Sims on the side of the fetal spine	Free position	120 women	Rotation to occiput anterior, type of delivery, postpartum perineal condition, perinatal results, maternal satisfaction	High risk of bias	In pregnant women undergoing labor in the Sims position, fetuses in POP rotated to occiput anterior in 50.8% of cases, whilst in the free position group, the rotation occurred in 21.7% (*P*=.001). The rate of vaginal deliveries was higher in the Sims group compared with the free position group (84.7% vs 68.3%, *P*=.035).
Masturzo 2017	Italy	Randomized controlled trial	Nulliparous in second-stage arrest of labor with fetus in cephalic presentation and OPP diagnosed by US	Fetal spine position was not known by the physician attending the delivery (group A)	Physician knew the spine position before attempting the MRFO (group B)	58 women	Success of MRFO, perineal injuries, blood loss, duration of expulsive period, neonatal Apgar at 5 minutes	Low risk of bias	A priori knowledge of the spine position improves the success of the MRFO (41.4% group A versus 82.8% group B, *P*<.001), the percentage of spontaneous deliveries (27.6% group A versus 69% group B, *P*=.01), and maternal outcome (intact perineum and blood loss). No differences were detected on the neonatal side.
Le Ray 2016	France	Randomized controlled trial	Women who labored with ruptured membranes and a	Lateral asymmetric decubitus posture on	Dorsal recumbent posture	322 women	Occiput anterior position at 1 hour	High risk of bias	One hour after random assignment, the rates of occiput anterior position did not differ between the intervention and control groups (21.9% vs 21.6%, respectively; *P*=.887). Occiput anterior rates did not differ between groups at complete

			term fetus that was confirmed by ultrasound imaging to be in cephalic posterior position	the side opposite that of the fetal spine during the first hour	during the first hour				dilation (43.7% vs 43.2%, respectively; *P*=.565) or at birth (83.1% vs 86.4%, respectively; *P*=.436). Finally, the groups did not differ significantly for cesarean delivery rates (18.1% among women in lateral asymmetric decubitus and 14.2% among control subjects (*P*=.608) or for speed of cervical dilation during the active first stage of labor (*P*=.684), pain assessment (*P*=.705), or women's satisfaction (*P*=.326). No maternal or neonatal adverse effect that was associated with either posture was observed.
Bertholdt 2019	France	Prospective, single-center study	Women with a singleton pregnancy at term with a fetus in an occiput posterior position for whom manual rotation was attempted	Manual rotation	n/a	233 deliveries	Success or failure of manual rotation, maternal and neonatal outcomes	Moderate risk of bias	Occiput posterior position was diagnosed in 233 (9.2%) of the 2,522 deliveries during the study period and the majority of cases were managed successfully by manual rotation (167 [71.7%]). Factors associated with successful rotation were fetal engagement (adjusted odds ratio [aOR] 2.20, 95% confidence interval [CI] 1.05–4.56), spontaneous labor (aOR 1.85, 95% CI 1.01–3.43), and no failure to progress (aOR 2.01, 95% CI 1.02–3.94). Successful manual rotation was associated with lower rates of cesarean (*P*<.001) and instrumental (*P*<.001) deliveries.
O'Brien 2017	United Kingdom	Retrospective cohort	Women who had singleton, cephalic pregnancies with persistent malposition at full cervical dilation and attempted RF or attempted MR followed by direct forceps births	Rotational forceps	Manual rotation and direct forceps	312 births	Maternal and neonatal outcomes	Moderate risk of bias	The rate of vaginal birth was significantly higher with rotational forceps than with manual rotation followed by direct forceps (88.5% vs 82.2%, RR 1.17, 95% CI 1.04–1.31, *P*=.017). Births by rotational forceps were associated with a significantly higher rate of shoulder dystocia (19.2% vs 10.6%, RR 2.35, 95% CI 1.23–4.47, *P*=.012), but not of neonatal injury. There were no significant differences in all other maternal and neonatal outcomes between the two modes of birth.
Tempest 2017	United Kingdom	Prospective and retrospective cohort	Women with operative births, in the second stage of labour, complicated with malposition of the fetal head	Manual rotation followed by direct traction instruments	Other methods of operative birth for fetal malposition	2,426 births	Neonatal outcomes (admission to the special care baby unit, low cord pH, low Apgar and shoulder dystocia) and maternal outcomes (massive obstetric haemorrhage (blood loss of >1500ml) and obstetric anal sphincter injury)	Moderate risk of bias	Births successfully assisted with manual rotation followed by direct traction instruments, resulted in 10% (36/346) of the babies being admitted to the Special Care Baby Unit, 4.9% (17/349) shoulder dystocia, 2% (7/349) massive obstetric haemorrhage and 1.7% (6/349) obstetric anal sphincter injury, similar to other methods of rotational births.

Shaffer 2011	United States	Retrospective cohort	Women during second stage of labour with the fetus in OP/OT position	Manual rotation	Expectant management	3,258 women	Mode of delivery, perinatal morbidity	Moderate risk of bias	Compared to expectant management, women with manual rotation were less likely to have: caesarean delivery (CD) [adjusted odds ratio (aOR) 0.12; 95% confidence interval (CI) 0.09–0.16], severe perineal laceration [aOR 0.64; (0.47–0.88)], postpartum haemorrhage [aOR 0.75; (0.62–0.98)], and chorioamnionitis [aOR 0.68; (0.50–0.92)]. The number of rotations attempted to avert one CD was 4. In contrast, women who had a trial of rotation had an increased risk of cervical laceration [aOR 2.46; (1.1-5.4)].
Le Ray 2007	France	Case-control	Live singletons in cephalic presentation at term after attempted vaginal delivery	Failed rotation	Successful rotation	796 patients	Mode of delivery, 5-minute Apgar scores, umbilical artery pH	Moderate risk of bias	The procedure failed in 77 (9.7%) women. Attempted rotation before full dilatation tripled the risk of failure in comparison with rotation at full dilatation (adjusted odds ratio 3.4, 95% CI 1.3– 8.6), and rotation for failure to progress quadrupled that risk in comparison with prophylactic rotation (adjusted odds ratio 3.3, 95% CI 1.2– 8.5). Failure of manual rotation was associated with a higher cesarean delivery rate than was success (58.8% compared with 3.8%, *P*<.001). All women with unsuccessful manual rotations who delivered vaginally delivered in the occiput posterior position, and all women with successful manual rotation delivering vaginally delivered in the occiput anterior position.

Management of Labor Arrest

Active Phase Arrest of Labor, Second Stage Arrest of Labor

Author, Year	*Setting*	*Design/ approach*	*Subjects*	*Intervention*	*Comparator*	*Sample size*	*Outcomes*	*Quality Assessment*	*Results*
PB #219 Operative Vaginal Delivery 2020	United States	Guideline	Pregnant women	Operative vaginal delivery	n/a	Systematic review/ meta-analyses, RCTs, observational studies, literature reviews	Risks and benefits	5.07 out of 7	Level A Recommendations: Forceps and vacuum extractors have low risk of complications and are acceptable for operative vaginal birth. A vaginal birth is more likely to be achieved with forceps than with vacuum extractors; however, forceps are more likely to be associated with third- and fourth-degree perineal tears. Routine episiotomy with operative vaginal birth is not recommended because poor healing and prolonged discomfort have been reported with mediolateral episiotomy and because of the association of midline episiotomies with increased risk of injury to the anal sphincter and extension into the rectum. Level B Recommendations: Operative vaginal birth is contraindicated if the fetal head is unengaged, the position of the fetal head is unknown, or a live fetus is known or strongly suspected to have a bone demineralization condition (eg, osteogenesis imperfecta) or a bleeding disorder (eg, alloimmune thrombocytopenia, hemophilia, or von Willebrand disease). A trial of operative vaginal birth is an appropriate option in a situation in which the obstetrician or obstetric care

									provider feels the chances of success are high but must be prepared to abandon the attempt if appropriate descent does not occur. Sequential use of vacuum extractor and forceps has been associated with increased rates of neonatal complications and should not routinely be performed. Cephalohematoma is more likely to occur as the duration of vacuum application increases. Midforceps and rotational forceps deliveries are appropriate options in select clinical circumstances. Level C Recommendations: Vacuum extraction has been discouraged for gestational age less than 34 weeks, although a safe lower limit for gestational age has not been established. For the fetus that manifests signs of compromise in the second stage of labor, the timely and skilled use of instrumental vaginal birth has the potential to decrease the exposure to intrauterine insults and could decrease the contribution of intrapartum factors leading to neonatal encephalopathy and hypoxic–ischemic encephalopathy. Neonatal care providers should be made aware of the mode of delivery in order to observe for potential complications associated with operative vaginal birth.
OCC #1 Safe Prevention of the Primary Cesarean Delivery 2014	United States	Guideline	Pregnant women	Mode of delivery	n/a	Systematic review/ meta-analyses, RCTs, observational studies, literature reviews	Prevention of cesarean delivery, adverse maternal and fetal outcomes	5.30 out of 7	Operative vaginal delivery in the second stage of labor by experienced and well-trained physicians should be considered a safe, acceptable alternative to cesarean delivery.
Verma 2021	Global	Systematic review and meta-analysis	Laboring women	Any type of forceps, low-cavity forceps, soft vacuum cup, handheld vacuum	Any type of vacuum cup, any rigid cup	31studies involving a total of 5,754 women	Failed delivery with allocated instrument, any maternal trauma, third- and fourth-degree tears, postpartum haemorrhage, any neonatal trauma, low Apgar and low umbilical artery pH	High quality review	Twelve studies involving 3,129 women compared any type of forceps with any vacuum cup. Forceps were more likely to achieve vaginal birth, but with a greater number of perineal tears including those affecting the anus or rectum (both low-certainty evidence). The was no evidence of a difference in rates of postpartum haemorrhage (heavy bleeding after birth) between groups (low-certainty evidence). There was no evidence of difference in the chances of low Apgar scores (a scoring system used to assess the baby's well-being at 1 and 5 minutes to determine how well they are coping after the birth) and low umbilical artery pH (blood test from the cord to assess the baby's oxygen levels immediately before birth) (both low-certainty evidence). Women who had forceps had higher pain relief requirements, although babies were less likely to be jaundiced. Two small studies in 218 women compared low forceps to any vacuum cup, but most of the evidence was of very low certainty, so no meaningful conclusion was drawn. Nine studies involving 1,148 women compared rigid cups with soft cups and found that rigid cups may be more likely to result in a successful delivery (low-certainty evidence), whilst there is probably no evidence of a difference in

									the rates of perineal tears affecting the anus or rectum or postpartum haemorrhages (low- and moderate-certainty evidence). In addition, there is no evidence of a difference in the rates of low Apgar and low umbilical artery pH (low-certainty evidence). In four studies with a total of 962 women we found no evidence of difference in the chances of a failed delivery between the handheld vacuum-cup group compared to the standard vacuum-cup devices (low-certainty evidence). In addition, there was no evidence of differences in the risk of maternal rectal tissue trauma (low-certainty evidence). Finally, there was no evidence of difference in the rates of postpartum haemorrhage, low umbilical artery pH or low Apgar between the two groups (low-certainty evidence).
Walker 2018	Global	Systematic review and meta-analysis	All pregnant women (primigravidae and multigravidae) in the second stage of induced or spontaneous labour receiving epidural analgesia	Maternal use of any upright position during the second stage of labour	Control condition in any recumbent position	8 randomised controlled trials involving 4,464 women	Operative birth, duration of second stage labour	High quality review	The overall evidence did not show a clear difference in operative births for women with an epidural during the second stage of labour. Differences in how well the studies were designed and conducted and differing positions adopted may account for this. However, the high-quality evidence showed better outcomes for women moving between lying-down on the side positions that avoided lying flat on the back. These positions result in more normal births, a better experience and no harm to mother or baby when compared with an upright position.
Pergialiotis 2014	Global	Systematic review and meta-analysis	Singleton childbearing women	Offered cesarean section at full dilatation	Offered cesarean section prior to full dilatation	10 studies 23,104 women	Maternal outcomes: death, ICU admission and need for transfusion Neonatal outcomes: death, neonatal unit admission and 5 min Apgar score less than 7	Moderate quality review	Second stage cesarean section seems to lead to higher maternal admissions to ICU (OR 7.41, 95% CI 2.47–22.5) and higher transfusion rates (OR 2.60, 95% CI 1.49–2.54). Neonatal death rates were also increased (OR 5.20, 95% CI 2.49–10.85) along with admissions to neonatal unit (OR 1.63, 95% CI 0.91–2.91) and rates of Apgar score less than 7 in 5 min (OR 2.77, 95% CI 1.02–7.50).
Hautakangas 2020	Finland	Randomized controlled trial	Parturients with singleton pregnancies, gestational age ≥37 weeks and fetus in cephalic position	Intrauterine tocodynamometry (IT)	External tocodynamometry (ET)	1,504 parturients	Rate of operative deliveries	High risk of bias	Operative delivery rates were 26.9% (IT) and 25.9% (ET) (odds ratio 1.05, 95% CI 0.84–1.32, *P*=.663). The ET to IT conversion rate was 31%. We found no differences in secondary outcomes (IT versus ET). IT reduced oxytocin use during labours with signs of fetal distress, and trial of labour after caesarean section.
Popowski 2015	France	Randomized controlled trial	Women with a singleton pregnancy in the vertex presentation at ≥37 weeks' gestation, cervical dilation	Digital vaginal examination (VE group)	Both digital vaginal and ultrasound examinations (VE+US group)	1,903 women	Operative delivery (Cesarean or instrumental vaginal delivery), maternal and fetal morbidity	High risk of bias	The overall rate of operative delivery was significantly higher in the VE+US group than in the VE group: 33.7% vs 27.1%, respectively (relative risk (RR), 1.24 (95% CI 1.08–1.43)), as was the rate of Cesarean delivery: 7.8% vs 4.9%, respectively (RR, 1.60 (95% CI 1.12–2.28)). The rate of instrumental vaginal delivery was also higher, albeit not significantly: 25.8% in the VE+US group vs 22.2% in the VE group (RR, 1.16 (95% CI 0.99–1.37)). Neonatal outcomes did not differ

			≥8 cm and who received epidural anesthesia						between the two groups. When analysis was restricted to instrumental vaginal deliveries only, maternal and neonatal morbidity outcomes were similar in both groups.
Ramphul 2014	Ireland	Randomized controlled trial	Nulliparous women at term (≥37 weeks of gestation) with singleton cephalic pregnancies	Ultrasound scan and clinical assessment (ultrasound)	Clinical assessment (standard care)	514 women	Incorrect diagnosis of the fetal head position	High risk of bias	The incidence of incorrect diagnosis was significantly lower in the ultrasound group than the standard care group (4/257, 1.6%, versus 52/257, 20.2%; odds ratio 0.06; 95% CI 0.02–0.19; *P*<.001). The decision to delivery interval was similar in both groups (ultrasound mean 13.8 minutes, SD 8.7 minutes, versus standard care mean 14.6 minutes, SD 10.1 minutes, *P*=.35). The incidence of maternal and neonatal complications, failed instrumental delivery, and caesarean section was not significantly different between the two groups.
Abbas 2021	Saudi Arabia	Retrospective cohort	Women who delivered at study institution	Vacuum extraction (VE)	Spontaneous delivery	745 patients	Maternal and neonatal complications	Moderate risk of bias	Of all deliveries, vacuum was used in 21.1%. Perineal tear was the most frequent maternal complication (20.9%), while caput succedaneum was the commonest neonatal complication (11.8%). Post-partum hemorrhage was significantly higher among vacuum deliveries (RR=18.8; 95% CI 5.5–64.15), as well as cephalohematoma (RR=28.9; 95% CI 8.79–95.04) and caput succedaneum (RR=18.6; 95% CI 10.99–31.49). The first-minute Apgar score was lower with VE (*P*<.001), and higher perineal tear degrees were reported with VE (*P*<.001).
Blanc-Petitjean 2021	France	Retrospective	Women with vaginal delivery, a term singleton cephalic fetus, without history of cesarean section	Active second stage of labor longer than 45 min (ASS ≥45 min, group A)	Women with instrumental vaginal delivery (IVD) only for failure to progress (FtP) before 45 min of pushing (group B)	261 women	Postpartum hemorrhage (PPH)	Moderate risk of bias	Prolonged ASS ≥45 min (group A, n=177) was associated with lower rate of persistent occiput posterior position (1.7 vs 9.5%, *P*<.01) and of non-engaged presentation when expulsive efforts started (10.7 vs 27.4%, *P*<.01), compared to IVD for FtP <45 min (group B, n=84). In group A, 52% of women had instrumental delivery. Prolonged active second stage was independently associated with lower odds of episiotomy (38.4 vs 61.9%, AOR (95%CI) =0.43 [0.24–0.78]) and was not associated with PPH (5.1 vs 5.9%, AOR=1.01 [0.28–3.68]), pH<7.20, 5-min Apgar score < 7 (20.2 vs 15.9%, AOR=2.00 [0.89-4.48]), lactates > 6 (23.0 vs 24.3, AOR=1.45 [0.68–3.07]) or transfer to neonatal intensive care unit (6.2 vs 2.4%), AOR=4.71 [0.76–29.08].
Butwick 2021	United States	Population-based cross-sectional	Women with singleton pregnancies who underwent operative vaginal (forceps or vacuum-assisted delivery)	Neuraxial labor analgesia	No neuraxial labor analgesia	106,845 women	Composite neonatal morbidity (5-min Apgar score less than 7, immediate assisted ventilation, assisted ventilation greater than 6 h, neonatal intensive care unit admission, neonatal transfer to a different facility within	Serious risk of bias	92,518 (86.6%) women received neuraxial analgesia. The proportion of neonates with morbidity was higher in the neuraxial analgesia group than the nonneuraxial group (10,409 of 92,518 [11.3%] vs. 1,271 of 14,327 [8.9%], respectively; *P*<.001). The unadjusted relative risk was 1.27 (95% CI 1.20–1.34; *P*< 0.001); after accounting for confounders using a multivariable model, the adjusted relative risk was 1.19 (95% CI 1.12–1.26; *P*<.001). In a post hoc analysis, after excluding neonatal intensive care unit admission and neonatal transfer from the composite outcome, the effect of neuraxial analgesia on neonatal morbidity was not statistically significant (adjusted relative risk, 1.07; 95% CI 1.00–1.16; *P*=.054).

							24 h of delivery, neonatal seizure or serious neurologic dysfunction)		
Lauterbach 2021	Israel	Retrospective case–control	Women following term vaginal delivery	First vaginal birth after cesarean (VBAC)	Control group comprised of women who had vaginal delivery without prior C-section	2,879 women	Postpartum hemorrhage (PPH) severity	Moderate risk of bias	Overall, significant postpartum complications, primarily PPH, were observed in the VBAC group compared to controls. Women who underwent C-section during second stage of labor experienced higher PPH rates and increased drop in hemoglobin levels compared to women who underwent C-section during the first stage of labor or an elective C-section. (4.3 ± 0.9 g/dL vs. 2.8 ± 1.1 g/dL vs. 2.4 ± 0.8, *P*=.033). Concomitant increased need for blood transfusion (8.1% vs. 3.5% vs. 2.9%, respectively, *P*<.0001) and uterine atony (12.6% vs. 6.2% vs. 4.4%, respectively, *P*=.009) were also observed. No significant differences were demonstrated in other postpartum adverse effects evaluated.
Blankenship 2020	United States	Retrospective analysis	Women admitted for delivery at ≥37 weeks and 0 to 7 days of gestation with singleton, nonanomalous, vertex infants	Above and below the 90th, 95th, and 97th percentiles for first stage of labor duration	Between groups	6,823 women	Maternal morbidity, neonatal morbidity	Serious risk of bias	682 were anticipated to have first stage of labor duration above the 90th percentile cutoff point, which was associated with an increased risk of composite maternal morbidity, maternal fever, postpartum transfusion, prolonged second stage of labor duration, third- or fourth-degree perineal laceration, and cesarean or operative vaginal delivery (*P*≤.02) and an increased risk of composite neonatal morbidity, respiratory distress syndrome, need for mechanical ventilation, and neonatal sepsis (*P*≤.03). Composite maternal morbidity was 2.2 (95% CI 1.8–2.7), 1.9 (95% CI 1.4–2.4), and 1.8 (95% CI 1.3–2.5) times more likely to occur among women above the 90th, 95th, and 97th percentile, respectively, for first stage of labor duration from 4 to 10 cm. Composite neonatal morbidity was 2.6 (95% CI 2.1–3.2), 2.2 (95% CI 1.7–2.9), and 1.9 (95% CI 1.3–2.8) times more likely to occur among infants delivered by women above the 90th, 95th, and 97th percentiles for first stage of labor duration from 4 to 10 cm. Receiver operating characteristic curves among all women from 4 to 10 cm and 6 to 10 cm, including when stratified by parity and type of labor onset, had an area under the curve of 0.51 to 0.62 and 0.53 to 0.71 for maternal and neonatal morbidity, respectively. Thus, duration of labor has moderate predictive ability, at best, for composite maternal or neonatal morbidity. No curve demonstrated a clear point at which adverse maternal or neonatal outcomes increased that could be used to define abnormal labor.
Bergh 2019	United States	Retrospective cohort	Women with a singleton pregnancy and without a prior uterine scar attempting a trial of labor	Emergent cesarean delivery with a skin-to-uterine incision (I-U) time of 3 minutes or less	Control group (women with an I-U time of 5 minutes or more)	1,722 patients	Adverse maternal outcomes	Moderate risk of bias	72 patients with an I-U time of 4 minutes were removed from the analysis. 196 patients (11.9%) had an I-U time ≤3 minutes and 1,454 patients (88.1%) had an I-U time ≥5 minutes. There were no differences in any outcomes between groups. The likelihood of transfusion, hysterectomy, or admission to the intensive care unit (ICU) was 1.5% in the emergent group and 1.0% in the control group (*P*=.334). Postpartum length of stay was also similar between the groups (3.3

									versus 3.2 days, *P*=.259). When 384 patients with I-U times >10 minutes were excluded, surgical outcomes remained similar between groups. Among the subgroup of patients who reached the second stage of labor, surgical outcomes were also similar between groups.
Dall'Asta 2019	Italy	Prospective cohort	Nulliparous women with a prolonged active second stage of labor	Spontaneous vaginal delivery	Obstetric intervention, either vacuum extraction or cesarean delivery	109 women	Relationship between transabdominal and transperineal sonographic findings in the prediction of spontaneous vaginal delivery	Moderate risk of bias	Spontaneous vaginal delivery and obstetric intervention were recorded in 40 (36.7%) and 69 (63.3%) patients, respectively. Spontaneous vaginal delivery was associated with a higher rate of occiput anterior position (90% vs 53.2%, *P*<.0001), lower head-perineum distance and head-symphysis distance (33.2 ± 7.8 mm vs 40.1 ± 9.5 mm, *P*=.001, and 13.1 ± 4.6 mm vs 19.5 ± 8.4 mm, *P*<.001, respectively), narrower midline angle (29.6° ±15.3° vs 54.2° ± 23.6°, *P*<.001) and wider angle of progression at the acme of the pushing effort (153.3° ± 19.8° vs 141.8° ± 25.7°, *P*=.02) and delta-angle of progression (17.3° ± 12.9° vs 12.5° ± 11.0°, *P*=.04). At logistic regression analysis, only the midline angle and the head-symphysis distance proved to be independent predictors of spontaneous vaginal delivery. More specifically, the area under the curve for the prediction of spontaneous vaginal delivery was 0.80, 95% CI 0.69–0.92, *P*<.001, and 0.74, 95% CI 0.65–0.83, *P*=.002, for the midline angle and for the head-symphysis distance, respectively.
Matta 2019	Australia	Retrospective cohort	Women with term, singleton pregnancies	Prolonged second stage of labour (PSSL)	No PSSL	48,352 women	Mode of birth and indication for emergency cesarean section, postpartum hemorrhage, perineal tears, five-minutes Apgar scores ≤3 and <7, severe acidosis (defined as umbilical artery pH <7.0, base excess ≤ −12 mmol/L or lactate >6 mmol/L), NICU admission, perinatal death	Moderate risk of bias	Women with PSSL were more likely to be nulliparous and have received oxytocin for augmentation of their labour (*P*<.001), less likely to have an epidural or have undergone induction of labour (*P*<.001). Women with PSSL were less likely to achieve a spontaneous vaginal delivery (adjusted odds ratio (aOR) 0.13, 95% CI 0.12–0.14, *P*< .001), more likely to undergo an instrumental delivery (aOR 3.93, 95% CI 3.62–4.25, *P*<.001) or emergency caesarean section (aOR 9.08, 95% CI 8.00–10.29, *P*<.001). PSSL was associated with shoulder dystocia (aOR 1.61, 95% CI 1.42–1.81, *P*<.001), and postpartum haemorrhage (aOR 1.37, 95% CI 1.16–1.60, *P*<.001). Univariate analysis demonstrated prolonged second stage of labour was associated with low five-minute Apgar score, acidosis and neonatal intensive care admission. However, after adjusting for potential confounders only five-minute Apgar scores ≤3 remained significantly increased (aOR 2.36, 95% CI 1.36–4.09, *P*=.002).
Metz 2017	United States	Cross-sectional	Candidates for operative vaginal delivery	Forceps, vacuum, and cesarean groups; fetuses in	One group vs. another; fetuses in either occiput posterior or occiput	5,910 women	Neonatal outcomes: Apgar scores, neonatal intensive care unit admission,	Moderate risk of bias	Total 3,771 (64%) women delivered with forceps, 1,474 (25%) vacuums, and 665 (11%) cesareans. Odds of forceps versus vacuum were higher with induction (OR=2.16, 95% CI 1.76–2.65), nulliparity (OR=2.06, 95% CI 1.59–2.66), epidural (OR=2.05, 95% CI 1.19–3.56), maternal indication (OR=1.53, 95% CI 1.16–2.02), older maternal age (OR 1.18, 95% CI

				occiput transverse position	anterior position		umbilical cord gases; Maternal outcomes: maternal delivery complications, failed operative vaginal delivery		1.06–1.31 per 5 years), and longer second stage (OR=1.10, 95% CI 1.01–1.20 per hour). Odds of cesarean versus operative vaginal delivery were higher with maternal indication (OR=9.0, 95% CI 7.23–11.20), a perinatologist (OR=2.51, 95% CI 1.09–5.78), longer second stage (OR=1.79, 95% CI 1.65–1.93 per hour), older gestational age (OR=1.10, 95% CI 1.01–1.20 per week), and longer labor (OR=1.02, 95% CI 1.01–1.04 per hour).
Palatnik 2016	United States	Case-control	Women undergoing an operative vaginal delivery	Shoulder dystocia at the time of operative vaginal delivery	Controls consisted of women without a shoulder dystocia at the time of operative vaginal delivery	4,080 women	Risk factors for shoulder dystocia	Moderate risk of bias	Shoulder dystocia occurred in 162 (4.0%) women. In bivariable analysis, maternal age, parity, body mass index, diabetes, chorioamnionitis, arrest disorder as an indication for an operative vaginal delivery, vacuum use, and estimated fetal weight >4 kg were significantly associated with shoulder dystocia. In multivariable analysis, parity, diabetes, chorioamnionitis, arrest disorder as an indication for operative vaginal delivery, vacuum use, and estimated fetal weight>4 kg remained independently associated with shoulder dystocia. The area under the curve for the generated receiver operating characteristic curve was 0.73 (95% CI 0.69–0.77), demonstrating only a modest ability to predict shoulder dystocia before performing an operative vaginal delivery.
Ragusa 2016	Italy	Prospective cohort	Nulliparous women with a singleton fetus in cephalic presentation at term in spontaneous or induced labor	Comprehensive management group (in acceleration of labor was commenced at the ‘‘action line’’ in the case of arrested or protracted labor)	Standard management group (in which arrested or protracted labor was considered as a warning sign promoting further diagnostic assessment prior to considering intervention)	419 patients	Labor progress, mode of delivery, neonatal outcomes	Moderate risk of bias	Caesarean sections rate was 22.2% in the SM group (216 patients) and 10.3% in the CM group (203 patients) (*P*=.001). The rate of oxytocin use decreased from 33.3% in SM group to 13.8% in the CM group (*P*<.0005). The rate of amniotomy decreased from 41.7% in the SM group to 7.4% in the CM group (*P*<.0005). The percentage of newborns with 5-min Apgar score <7 and/or umbilical cord arterial pH B 7.00 decreased from 2.3% in SM cohort to 0.5% in CM cohort (*P*=ns). The average length of labor did not differ between the two groups of patients (264 vs 277 min; *P*=ns).
Verhoeven 2016	Netherlands	Retrospective case-control	Women who underwent a failed vacuum-assisted delivery	Failed vacuum extraction	Control- successful vacuum extraction	309 cases (618 controls)	Potential risk indicators for failed vacuum extraction	Moderate risk of bias	Predictors for failed vacuum-assisted vaginal delivery were increasing gestational age (OR 1.2 per week), maternal height (OR 0.97 per cm), previous vaginal birth as compared to nulliparae (OR 0.32), estimated fetal weight $\geq$3750 g as compared to <3250 g (OR 5.7), epidural analgesia (OR 3.0), augmentation (OR 1.4), failure to progress as indication for trial of vacuum delivery (OR 1.7), station of descent of the fetal head (OR 0.31 per station more descended), and occiput posterior position (OR 2.6). The area under the receiver-operating characteristic curve of a prediction model integrating these indicators was 0.83.
Hunt 2015	Canada	Retrospective chart review	Nulliparous women who delivered after a prolonged	Second stage lasting more than 3 hours	Second stage lasting less than 3 hours	1,515 women	Five minute Apgar score < 7, cord arterial	Serious risk of bias	The majority of women (67%) delivered vaginally, after up to 10 hours in the second stage of labour. The overall rate of Caesarean section was low (15.7%). The rate of permanent neurologic impairment was 2.6 per 1,000 deliveries.

			second stage of labour				pH < 7.10, admission to the NICU, neonatal seizures, neonatal death		
Lurie 2014	Israel	Retrospective cohort	Term parturient women with singleton pregnancy in vertex presentation who underwent primary cesarean section during active labor	First stage of labor	Second stage of labor	382 women	Maternal intraoperative and postoperative morbidity, immediate neonatal outcome (cord pH and Apgar score)	Moderate risk of bias	A significantly higher rate of unintentional uterine incision extensions was observed in cesarean sections performed during second stage compared to first stage (17.1% vs. 4.6%, *P*=.001). It was higher whenever (at first or second stage) the fetal head was pushed (20.0% vs. 5.4%, *P*=.0024). Unintentional uterine incision extensions were significantly more frequent when the cesarean section was performed for non-progressive labor during the second stage compared to first stage (16.1% vs. 3.6%, *P*=.0052). Uterine atonia was more frequent among parturient women who underwent cesarean section for nonprogressive labor during the first stage compared to second stage (16.7% vs. 4.8%, *P*=.0382).
Tuuli 2014	United States	Retrospective cohort	Singleton, term, cesarean deliveries in laboring women	Second stage cesareans	First stage cesareans	2,505 cesareans	Endometritis	Moderate risk of bias	400 cesareans (16.0%) were performed in the second stage while 2,105 (84.0%) were performed in the first stage of labor. The risk of endometritis was nearly 3-fold higher in second compared to first stage cesareans (4.25% vs 1.52%, crude OR 2.88 [95% CI 1.58–5.23]). The risk remained significantly higher after controlling for confounders (adjusted OR 2.78 [95% CI 1.51–5.09]).
Carseldine 2013	Australia	Double-blinded prospective cohort	Women with a singleton pregnancy, cephalic presentation, had reached full cerical dilatation, and delivery was thought not to be imminent	Ultrasound determined occiput-posterior position during second stage of labor	Ultrasound determined occiput-anterior position	160 women	Operative (caesarean section, forceps or vacuum) delivery	Low risk of bias	A total of 68% (13/19) women in the occiput-posterior group, and 27% (39/141) in the occiput-anterior group had an operative delivery (unadjusted: *P*<.001). Caesarean section was performed in 37% and 5%, respectively (*P*<.001). The occiput-posterior group had a longer second stage (mean 2 h 59 minutes vs 1 h 54 minutes; *P*=.001) and larger infants (mean 3723 g vs 3480 g, *P*=.024). In the logistic regression, occiput-posterior position, nulliparity, abnormal second stage cardiotocograph and epidural analgesia were independent predictors for operative delivery.
Barber 2011	United States	Medical record analysis	Live births	Rates of primary and repeat cesarean delivery and vaginal birth after cesarean (VBAC)	Over different time periods	32,443 births	Time trends, indications for cesarean	Serious risk of bias	The cesarean delivery rate increased from 26% to 36.5% between 2003 and 2009; 50.0% of the increase was attributable to an increase in primary cesarean delivery. Among the documented indications, non-reassuring fetal status, arrest of dilation, multiple gestation, preeclampsia, suspected macrosomia, and maternal request increased over time, while arrest of descent, malpresentation, maternal-fetal indications, and other obstetric indications (eg, cord prolapse, placenta previa) did not increase. The relative contributions of each indication to the total increase in primary cesarean rate were: Non-reassuring fetal status (32%), labor arrest disorders (18%), multiple gestation (16%), suspected macrosomia (10%), pre-eclampsia (10%), maternal request (8%), maternal-fetal conditions (5%), and other obstetric conditions (1%).

Sucak 2011	Turkey	Prospective observational audit	Nullipara women who had undergone cesarean section	Primary cesarean sections in first stage of labor	Primary cesarean sections in second stage of labor	1,389 women	Uterine atonia, transfusion requirement, urinary system injury, requirement for hysterectomy, and duration of hospital stay	Moderate risk of bias	Of these 1,389 cesarean sections, 1,271 were in the first stage of the labour and 171 were in the second stage of the labour. Urinary injuries, transfusion requirement, and uterine atonia hysterectomy were significantly more frequent in women who underwent cesarean section in the second stage of the labour compared to women undergoing cesarean section in the first stage of the labour.
Werner 2011	United States	Cross-sectional	Singleton live births at 34 weeks or greater gestation born to nulliparous women	Forceps-assisted vaginal deliveries	Vacuum-assisted vaginal deliveries, cesarean deliveries	414,999 total deliveries (122,507 operative deliveries for analysis)	Maternal and neonatal outcomes	Moderate risk of bias	Forceps-assisted vaginal deliveries were associated with significantly fewer seizures and 5-minute Apgar scores less than 7 compared with vacuum-assisted vaginal deliveries and cesarean deliveries. Cesarean deliveries were linked to less subdural hemorrhages compared with forceps-assisted vaginal deliveries or vacuum-assisted vaginal deliveries. When seizure, intraventricular hemorrhage, and subdural hemorrhage were examined collectively to best predict neurologic outcome, forceps-assisted vaginal deliveries had an overall reduced risk compared with both vacuum-assisted vaginal deliveries (odds ratio [OR] 0.60, 95% CI 0.40–0.90) and cesarean deliveries (OR 0.68, 95% CI 0.48–0.97). The number needed to treat to prevent one case of severe neurologic morbidity is 509 for forceps-assisted vaginal deliveries compared with vacuum-assisted vaginal deliveries and 559 for forceps-assisted vaginal deliveries compared with cesarean deliveries.
Cheng 2010	United States	Retrospective cohort	Women with full-term, cephalic singletons	Occiput posterior (OP) positions at delivery	Occiput anterior positions	18,880 women	Perinatal outcomes	Moderate risk of bias	Persistent OP position was associated with operative delivery and maternal morbidity. The odds ratio estimates based on propensity score analysis (PSA) was somewhat larger than those obtained with standard multivariable logistic regression (MVLR), and the confidence intervals were narrower. When statistical inference was evaluated with the permutation test, the results were more consistent with the PSA. These analyses demonstrate that PSA is likely to provide more precise estimates of exposure associations and more reliable statistical inferences than MVLR.
Contag 2010	United States	Secondary analysis of a randomized trial	Low risk, nulliparous women at ≥ 36 weeks' gestation in second stage of labor at station +1 or below (thirds scale) for failure of descent or non-reassuring fetal status	Forceps, vacuum, and cesarean	Comparisons between interventions	990 women	Neonatal outcomes (Apgar scores, umbilical artery pH, umbilical artery base excess, highest level of neonatal care)	Moderate risk of bias	549 (55%) with an indication for delivery of failure of descent and 441 (45%) for a non-reassuring fetal status. Umbilical cord gases were available for 87% of neonates. We found no differences in the base excess (*P*=.35 and 0.78 for failure of descent and non-reassuring fetal status) or frequencies of pH below 7.0 (*P*=.73 and 0.34 for failure of descent and non-reassuring fetal status) among the three delivery methods. Birth outcomes and umbilical cord blood gas values were similar for those neonates with a forceps assisted, vacuum-assisted or cesarean delivery in the second stage of labor.

Srinivas 2010	United States	Observational	Women undergoing cesarean delivery (CD) and vaginal delivery (VD)	CDs	VDs	Over 6 million women	Composite measure of major maternal complications including infection, hemorrhage, laceration, other major operative and thrombotic complications	Serious risk of bias	During the 15-year time period, the CD rate decreased from 24.7% in 1992 to 23% in 1996 and increased to 34.7% in 2006. The risk-adjusted rate of any major complication declined from 14.7% in 1992 to 10.7% in 2006 for all deliveries; from 14.4% to 11.6% for VD; and from 15.7% to 8.5% for CD. During 1992 to 2006, the average number of comorbidities increased from 0.65 to 0.93 for patients overall, from 0.43 to 0.58 for VD patients, and 1.34 to 1.59 for CD patients.
Leushuis 2009	Netherlands	Retrospective cohort	Women with singleton cephalic live births at a gestational age of 37.0 weeks or more who had entered the expulsive second stage of labour	Expulsive second stage arrest of labor	Spontaneous delivery	389,086 women (37,899 in second stage arrest)	Ante- and intrapartum indicators for interventions during expulsive second-stage arrest of labour	Moderate risk of bias	Primiparous delivery was the most important antepartum indicator for intervention during expulsive second-stage arrest. Using multivariable analysis, the following antepartum indicators were associated with intervention for expulsive second-stage arrest of primiparous labour: maternal age, gestational age, diabetes, hypertension, and labour induction. Prominent intrapartum indicators for primiparous deliveries were fetal head position and oxytocin augmentation.
Henry 2008	United States	Retrospective cohort	Women with term, singleton, cephalic gestations diagnosed with active phase arrest of labor	Active phase arrest who underwent a cesarean delivery; delivered vaginally with active phase arrest	Delivered vaginally; without active phase arrest	1,014 women	Diagnosis of active phase arrest, mode of delivery, frequency of chorioamnionitis, endomyometritis, postpartum hemorrhage, severe postpartum hemorrhage, blood transfusion, Apgar score, acidemia, neonatal sepsis, frequency of admission to NICU	Moderate risk of bias	33% (335) went on to deliver vaginally and the rest were delivered by cesarean. Cesarean delivery was associated with an increased risk of chorioamnionitis (aOR 3.37, 95% CI [2.21–5.15]), endomyometritis (aOR 48.41, [6.61–354]), postpartum hemorrhage (aOR 5.18, [3.42–7.85]), and severe postpartum hemorrhage (aOR 14.97, [1.77–126]). There were no differences in adverse neonatal outcomes. Among women who delivered vaginally, women with active phase arrest had significantly increased odds of chorioamnionitis (aOR 2.70, [1.22–2.36]]), and shoulder dystocia (aOR 2.37, [1.33–4.25]). However, there were no differences in the serious sequelae associated with these outcomes, including neonatal sepsis and Erb's palsy.
Fitzgerald 2007	United States	Analysis	Women who delivered vaginally	Anal sphincter tear	No anal sphincter tear	797 women	Risk factors for anal sphincter tear	Moderate risk of bias	Based on univariable analysis, a woman with a sphincter tear was more likely to be older, to be white, to have longer gestation or prolonged second stage of labor, to have a larger infant (birth weight/head circumference), or an infant who was in occiput posterior position, or to have an episiotomy or

									operative delivery. Logistic regression found forceps delivery (OR 13.6, 95% CI 7.9–23.2) and episiotomy (OR 5.3, 95% CI 3.8–7.6) were strongly associated with a sphincter tear. The combination of forceps and episiotomy was markedly associated with sphincter tear (OR 25.3, 95% CI 10.2–62.6). The addition of epidural anesthesia to forceps and episiotomy increased the OR to 41.0 (95% CI 13.5–124.4).
Mazouni 2006	France	Retrospective case-control	Nulliparous patients presenting in labor at full term (>37 weeks gestation) with singleton vertex fetuses who underwent forceps vaginal delivery	Instrumental delivery	Spontaneous vaginal delivery	582 women	Duration of first stage, duration of second stage, maternal morbidity	Moderate risk of bias	The strongest risk factors for forceps delivery were birth weight greater than 4000 g (OR: 6.5; 95% CI 1.6–26.9), the occiput posterior position of the fetal head (OR: 5.8; 95% CI 2.5–13.8), and epidural analgesia (OR: 7.7; 95% CI 4.1–14.7). Other significant risk factors for forceps delivery were age over 35 years (OR: 2.4; 95% CI 1.1–5.1), induction of labor (OR: 2.1; 95% CI 1.4–3.1), first stage of labor longer than 420 min (OR: 2.3, 95% CI 1.3–4.2), and a prolonged second stage of labor (OR: 1.6, 95% CI 1.1–2.4).
Benavides 2005	United States	Retrospective cohort	Women with singleton, cephalic, forceps-assisted vaginal deliveries	Occiput anterior (OA) position	Occiput posterior (OP) position	588 deliveries	Risk for anal sphincter injury	Moderate risk of bias	The prevalence of occiput anterior (OA) and OP positions was 88.4% and 11.6%, respectively. The groups were similar in age, marital status, body mass index, use of epidural, frequency of inductions, episiotomies, and shoulder dystocias. The OA group had a higher frequency of rotational forceps (16.2% vs 5.9%, *P*=.03), greater birth weights (3304 G 526 g vs 3092 G 777 g, *P*=.004), and a larger percentage of white women (48.8% vs 34.3%, *P*=.04). Overall, 35% of forceps deliveries resulted in a third- or fourth-degree laceration. Anal sphincter injury occurred significantly more often in the OP group compared with the OA group (51.5% vs 32.9%, *P*=.003), giving an odds ratio of 2.2 (CI 1.3–3.6). In a logistic regression model that controlled for occiput posterior position, maternal body mass index, race, length of second stage, episiotomy, birth weight, and rotational forceps, OP head position was 3.1 (CI 1.6–6.2) times more likely to be associated with anal sphincter injury than OA head position.
Magann 2005	Australia	Database analysis	Women delivering at study hospital	Postpartum hemorrhage (PPH) in vaginal delivery	No PPH	18,735 women and 19,476 infants (4,867 women delivered by cesarean and 13,868 delivered vaginally)	Risk factors for PPH	Serious risk of bias	Identified risk factors for PPH were Asian race, maternal blood disorders, prior PPH, history of retained placenta, multiple pregnancy, antepartum hemorrhage, genital tract lacerations, macrosomia (>4 kg), and induction of labor, as well as chorioamnionitis, intrapartum hemorrhage, still birth, compound fetal presentation, epidural anesthesia, prolonged first/second stage of labor, and forceps delivery after a failed vacuum.

Gopalami 2004	United States	Population-based case-control	Women who delivered a live-born, singleton infant by labored primary or repeat cesarean section, and who also had an operative vaginal delivery	Live-born singletons with both labored cesarean delivery and an operative vaginal delivery	Controls were singletons undergoing a successful operative vaginal delivery	5,250 births	Factors related to failed or successful operative vaginal delivery	Moderate risk of bias	Failed operative vaginal delivery was associated with increased maternal age, African American race, higher body mass index (BMI), diabetes, polyhydramnios, induction of labor, dysfunctional labor, and prolonged labor. Case compared with control mothers were more likely to deliver a low-birth weight or macrosomic infant.
Feinstein 2002	Israel	Analysis	Singleton, vertex, term deliveries with an unscarred uterus	Complicated with arrest of descent in second stage	Not complicated by arrest of descent in second stage	93,266 deliveries	Large for gestational age, small for gestational age, perinatal death, Apgar scores	Moderate risk of bias	1,545 (1.7%) were complicated with arrest of descent during the second stage of labor. Using a multivariable analysis, the following obstetric risk factors were found to be significantly associated with arrest of descent: nulliparity (OR=7.8, 95% CI 6.9–8.7; *P*<.001), birth weight >4 kg (OR=2.3, 95% CI 1.9–2.8; *P*<.001., epidural analgesia (OR=1.8, 95% CI 1.6–2.0; *P*<.001), hydramnios (OR=1.6, 95% CI 1.3–2.0; *P*<.001), hypertensive disorders (OR=1.5, 95% CI 1.3–1.8; *P*<.001), gestational diabetes A1 and A2 (OR=1.5, 95% CI 1.2–1.8; *P*<.001), male gender (OR=1.4, 95% CI 1.2–1.5; *P*<.001), premature rupture of membranes (PROM, OR=1.3, 95% CI 1.04–1.6; *P*<.021, and induction of labor (OR=1.2, 95% CI 1.02–1.4; *P*<.030). Deliveries complicated by arrest of descent resulted in cesarean section in 20.6%, vacuum extraction in 74.0%, and forceps delivery in 5.4%. Newborns delivered after arrest of descent during the second stage of labor had significantly higher rates of low Apgar scores (<7 at 1 and 5 min, as compared to the controls (12.7 vs. 2.1%, *P*<.001; and 0.9 vs. 0.2%, *P*<.001) respectively. Nevertheless, no significant differences were noted between the groups regarding perinatal mortality (0.38 vs. 0.44%; *P*<.759).
Murphy 2001	United Kingdom	Prospective cohort	Women at term (>37 weeks' gestation) with live singleton pregnancies and a cephalic vertex presentation at full dilation	Vaginal instrumental delivery	Caesarean section	393 women	Maternal morbidity (haemorrhage, infection, uterine trauma, perineal trauma, length of stay in hospital, analgesia requirements, wound problems, feeding difficulties), neonatal morbidity	Moderate risk of bias	Factors increasing the likelihood of caesarean section included maternal body mass index greater than 30 (adjusted odds ratio 2.4, 95% CI 1.2–4.9), neonatal birthweight greater than 4.0 kg (2.3, 1.3–3.8), and occipitoposterior position (2.5, 1.6–3.9). Women undergoing caesarean section were more likely to have a major haemorrhage (>1 L; 2.8, 1.1–7·6) and extended hospital stay (≥6 days; 3.5, 1.6–7.6) than those with vaginal delivery. Babies delivered by caesarean section were more likely to require admission for intensive care (2.6, 1.2–6.0) but less likely to have trauma (0.4, 0.2–0.7) than babies delivered by forceps. Overall neonatal morbidity was low, but a few babies in each group had serious complications (serious trauma, eight vs three; sepsis, six vs 13; and jaundice, ten vs 12 after vaginal delivery and caesarean section, respectively). Major haemorrhage was less likely after delivery by a skilled obstetrician (0.5, 0.3–0.9).

Towner 1999	United States	Database analysis	Nulliparous women	Vacuum extraction, cesarean delivery, use of forceps, combined use of forceps and vacuum extraction	Spontaneous vaginal delivery	583,340 live-born singleton infants	Neonatal outcomes	Serious risk of bias	Intracranial hemorrhage occurred in 1 of 860 infants delivered by vacuum extraction, 1 of 664 delivered with the use of forceps, 1 of 907 delivered by cesarean section during labor, 1 of 2,750 delivered by cesarean section with no labor, and 1 of 1,900 delivered spontaneously. As compared with the infants delivered spontaneously, those delivered by vacuum extraction had a significantly higher rate of subdural or cerebral hemorrhage (odds ratio, 2.7; 95% CI 1.9–3.9), as did the infants delivered with the use of forceps (odds ratio, 3.4; 95% CI 1.9–5.9) or cesarean section during labor (odds ratio, 2.5; 95% CI 1.8–3.4), but the rate of subdural or cerebral hemorrhage associated with vacuum extraction did not differ significantly from that associated with forceps use (odds ratio for the comparison with vacuum extraction, 1.2; 95% CI 0.7–2.2) or cesarean section during labor (odds ratio, 0.9; 95% CI 0.6–1.4).

Health Equity

Author, Year	*Setting*	*Design/approach*	*Subjects*	*Intervention*	*Comparator*	*Sample size*	*Outcomes*	*Quality Assessment*	*Results*
Crossland 2020	Global	Systematic review and qualitative meta-ethnographic approach	Maternity service users (including birth companions), health care providers, policy makers and funders	Assisted vaginal birth	n/a	42 studies	Views, experiences, opinions, acceptability, clinical decision making, attitudes, facilitators, enablers, barriers, attitude of health personnel, satisfaction	Low quality review	Confidence in the findings was moderate or low. Spontaneous vaginal birth was most likely to be associated with positive short and long-term outcomes, and emergency CS least likely. Views and experiences of AVD tended to fall somewhere between these two extremes. Where indicated, AVD can be an effective, acceptable alternative to caesarean section. There was agreement or partial agreement across qualitative studies and surveys that the experience of AVD is impacted by the unexpected nature of events and, particularly in high-income settings, unmet expectations. Positive relationships, good communication, involvement in decision-making, and (believing in) the reason for intervention were important mediators of birth experience. Professional attitudes and skills (development) were simultaneously barriers and facilitators of AVD in quantitative studies.
Blumenshine 2010	Global	Systematic review and meta-analysis	Population subgroups	SES measure	Comparisons between subgroups	106 studies	Socioeconomic factors, adverse birth outcomes	Moderate quality review	Socioeconomic disadvantage was consistently associated with increased risk across socioeconomic measures, birth outcomes, and countries; many studies observed racial/ethnic differences in the effect of socioeconomic measures.

Chiu 2020	United States	Retrospective unmatched case-control	Women with singleton gestation, spontaneous deliveries, and vacuum-assisted or forceps-assisted deliveries in cephalic presentation	Third- or fourth-degree lacerations	Control	23,362 deliveries	Incidence rate of obstetric anal sphincter injuries (OASIs) (third- and fourth-degree lacerations), maternal, obstetric, and fetal variables associated with OASIs during delivery	Serious risk of bias	The incidence of OASIs was 1%. Of our patients, 38% self-identified as Hispanic, 32% as Black, 13% as White, and 3.5% as Asian. Risk for OASIs was significantly increased in nulliparity, Pitocin use, operative deliveries, episiotomy, and prolonged second stage of labor. Black race and obesity were protective for OASIs. There was no significant difference in complication rates based on type of repair nor the provider level of training.
Altman 2020	United States	Qualitative (semistructured interviews)	Pregnant women of color from a community-based organization	Interview	n/a	22 women		Moderate risk of bias	Participants shared experiences and provided recommendations for improving care at the individual health care provider level, including spending quality time, relationship building and making meaningful connections, individualized person-centered care, and partnership in decision making. At the health systems level, recommendations included continuity of care, racial concordance with providers, supportive health care system structures to meet the needs of women of color, and implicit bias trainings and education to reduce judgment, stereotyping, and discrimination.
Yee 2017	United States	Secondary analysis of observational study	Term women with singleton, nonanomalous, vertex, liveborn neonates	Grouped as non-Hispanic black, non-Hispanic white, Hispanic, and Asian	Comparisons between groups	75,400 women	Indication for cesarean delivery	Serious risk of bias	The frequencies of cesarean delivery were 25.8% among nulliparous women and 6.0% among multiparous women. For nulliparous women, the unadjusted cesarean frequencies were 25.0%, 28.3%, 28.7%, and 24.0% for non-Hispanic white, non-Hispanic black, Asian, and Hispanic women, respectively. Among nulliparous women, the adjusted odds of cesarean were higher in all racial and ethnic groups compared with non-Hispanic white women (non-Hispanic black aOR 1.47, 95% CI 1.36–1.59; Asian aOR 1.26, 95% CI 1.14–1.40; Hispanic aOR 1.17, 95% CI 1.07–1.27), due to greater odds of cesarean delivery both for nonreassuring fetal status and labor dystocia. Nonapplication of labor management strategies regarding failed induction, arrest of dilation, arrest of descent, or cervical ripening did not contribute to increased odds of cesarean delivery for non-Hispanic black and Hispanic women. Compared with non-Hispanic white, Hispanic women were actually less likely to experience elective cesarean (aOR 0.60, 95% CI 0.42–0.87) or cesarean for arrest of dilation prior to 4 hours (aOR 0.67, 95% CI

									0.49–0.92). Additionally, compared with non-Hispanic white, Asian women were more likely to experience cesarean for nonreassuring fetal status (aOR 1.29, 95% CI 1.09–1.53) and to have had that cesarean be performed in the setting of a 1-minute Apgar score ≥7 (aOR 1.79, 95% CI 1.07–3.00). A similar trend was seen among multiparous women with prior vaginal deliveries.
Cheng 2006	United States	Retrospective cohort	Term, singleton, vertex vaginal deliveries	Maternal and labor characteristics	Compared between shoulder dystocia and no shoulder dystocia for secondary outcomes	29,612 deliveries	Occurrence of shoulder dystocia, perinatal outcomes	Moderate risk of bias	524 (1.8%) experienced a shoulder dystocia. African American women had the highest risk of shoulder dystocia (2.6%), compared with other races/ethnicities (*P*=.001). Women who delivered in occiput posterior position were noted to have a lower risk for shoulder dystocia (1.1%) as compared with occiput anterior position (1.8%, *P*=.046). However, in the setting of a shoulder dystocia, a higher risk of brachial plexus injury was observed in neonates delivered in occiput posterior position (adjusted odds ratio 10.4, 95% CI 3.03–35.88) by vacuum-assisted vaginal delivery (adjusted odds ratio 3.24, 95% CI 1.37–7.67) and neonates weighing 4000g or more (adjusted odds ratio 2.53, 95% CI 1.09–5.85).

Quality Assessment Definitions

There are 4 main types of references, evaluated using a corresponding quality assessment tool:

• Guidelines: AGREE-II

o The overall rating is generated by averaging the scores of all 23 items and will be on a scale of 1–7, with 7 being the highest quality

• Systematic Reviews/Meta-Analyses: AMSTAR 2

o An overall rating of quality of the evidence will be rated as High, Moderate, Low, or Critically Low-Quality Review, based on 16 domains

• Randomized Control Trials: Cochrane Collaboration's tool

o Each of the 7 domains will be rated as low, high, or unclear risk of bias, with a brief summary of the findings in the evidence table

• Observational Studies: ROBINS-I

o For each of the 7 domains, the risk of bias will be judged as low, moderate, serious, or critical risk of bias (or no information), with a brief summary of the findings in the evidence table