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Elective Cesarean Section and Induction and Their Impact on Late Preterm Births

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Complications of prematurity account for 85% of perinatal morbidity and mortality in the United States [1]. Although severely preterm infants are more likely to suffer consequences of prematurity, late preterm births account for the majority of preterm deliveries and experience significantly more morbidity than infants born at term [2]. Recent efforts have focused on further assessing the outcomes of these late preterm infants and understanding their etiologies. This article will explore incidence of elective cesarean section and induction of labor and their impact on the timing of delivery and the increasing incidence of late preterm births.

Definition and incidence of late preterm births

The American College of Obstetrics and Gynecology (ACOG) and the American Academy of Pediatrics define term pregnancy as one that has completed 37 weeks of gestation and that delivers after the first day of the 38th week of pregnancy. In contrast, preterm deliveries are those that occur before 37 completed weeks of gestation. The group of infants labeled "preterm" is, however, extremely heterogeneous, and is applied to infants born at a wide range of gestational ages, which are associated with vastly different outcomes. According to the consensus statement of the National Institute of Child Health and Human Development (NICHD) workshop entitled "Optimizing Care and Outcome of the Near-Term Pregnancy and the Near-Term Newborn Infant," infants born 34 weeks 0 days and 36 weeks 6 days gestation should be classified as "late preterm" infants [3]. Although these late preterm infants have also been referred to as "near

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term" or "minimally preterm," these labels have fallen out of favor as they are inconsistently defined and may misleadingly imply fetal maturity [4].

In 2004, the premature birth rate in the United States was 12.5%, representing a more than 30% increase since 1981 [5]. Although the number of infants born at less than 32 weeks has declined slightly since 1990, the birth of infants born between 32 and 37 weeks has increased over the same time period [6]. Late preterm births accounted for 6.9% of singleton births in the United States in 1992 and increased to 7.4% of singleton deliveries in 2002 [6]. Data from the US National Center for Health Statistics demonstrate that 74% of the 394,996 preterm singleton deliveries in the United States in 2002 occurred at either 34, 35, or 36 weeks gestation [6].

Impact

Numerous studies have shown that late preterm infants face increased morbidity when compared with their term counterparts. Although meconium aspiration syndrome is less common in late preterm infants than in term infants [7], all other forms of respiratory morbidity (including transient tachypnea of the newborn, respiratory distress syndrome, pneumonia, and pulmonary hypertension) affect late preterm infants at a higher rate than infants of more advanced gestational ages [8,9]. Hypothermia is another consequence of late preterm delivery and has been shown to trigger unnecessary sepsis investigations and more frequent neonatal intensive care unit (NICU) admissions in the late preterm population [10]. The suck-swallow reflex and intestinal motility is also impaired in late preterm infants, and can lead to difficulty breastfeeding and a higher likelihood of poor weight gain and dehydration [11]. Among infants born between 34 and 37 weeks gestation, the incidence of hypoglycemia is also significantly higher than demonstrated in term infants [10]. The relative immaturity of the livers of late preterm infants makes hyperbilirubinemia and posticteric sequelae more common and more severe in infants born in the late preterm period than in infants born at term [12].

In addition to the increased morbidity faced by late preterm infants, several studies have also demonstrated an increased risk of infant mortality among infants born between 34 and 37 weeks gestation [7]. One study demonstrated a two- to fivefold increased risk of infant death among late preterm infants and a twofold higher risk of sudden infant death syndrome when late preterm infants were compared with infants delivered at term [13]. Although the majority of late preterm infants survive the neonatal period, recent evidence also suggests that preterm and low birth weight infants suffer from long-term behavioral and developmental morbidities. One study with long-term follow up of low-birth weight infants demonstrated clinically significant behavioral problems in almost 20% of the infants born between 34 and 37 weeks gestation [14]. Compared with children born at term,

infants born between 34 and 36 weeks gestation have an 80% increased risk of childhood attention-deficit/hyperactivity disorder [15].

Because late preterm infants account for the majority of preterm infants in the United States and experience increased morbidity compared with their term counterparts, late preterm births impose an enormous impact on the health care system. Late preterm infants accrue increased hospital expenses during their delivery hospitalizations [2] and have a higher rate of rehospitalization than infants born after 37 weeks of gestation [16,17]. A population-based cohort study demonstrated a 4.8% rehospitalization rate among late preterm infants, even with no history of prior NICU admission during the delivery hospitalization [16]. It has also been demonstrated that late preterm infants are 1.8 times as likely as term infants to require readmission; breastfed late preterm infants are at even higher risk of requiring readmission [17]. One estimate suggests that over 49 million dollars could be saved if nonindicated deliveries between 34 and 37 weeks were avoided for 1 year in the state of California alone [18].

Causes of late preterm birth

Spontaneous preterm labor and preterm rupture of membranes

Although the overall rate of preterm birth is on the rise, the rate of preterm delivery resulting from spontaneous preterm labor (PTL) before 32 weeks decreased by 9% between 1992 and 2002 [5]. Paradoxically, the rate of spontaneous preterm delivery among late preterm infants increased during the same period. By 2002, more than 7% of deliveries resulting from PTL occurred between 34 and 37 weeks gestation; this represented a 12% increase in births resulting from spontaneous late PTL between 1992 and 2002 [6]. The rate of premature rupture of membranes (PROM) between 34 and 36 weeks gestation also increased from 1992 to 2002; by 2002, 21% of cases of PROM occurred in late preterm pregnancies [6].

Standard obstetric management of PTL and preterm PROM (PPROM) may influence the percentage of these cases that result in late preterm birth beyond 34 weeks. According to practice guidelines published by the ACOG, the management of PTL should involve the use of tocolysis and glucocorticoids up to 34 weeks gestation [19]. The management of PPROM remains controversial, but expert opinion generally recommends expectant management before 34 weeks [20]. However, beyond 34 weeks efforts are no longer directed at prolonging the pregnancy. These management strategies are based upon the fact that the survival rate of infants born at 34 weeks is within 1% of those born at term and prolongation of a pregnancy complicated by PTL or PPROM beyond 34 weeks may have unnecessary maternal and fetal risk [21].

The practice of not aggressively attempting to treat PTL after 34 weeks of gestation may have contributed to the increasing rate of late preterm births. In addition, many practitioners actively deliver pregnancies with ruptured

membranes beyond 34 weeks, or even earlier if fetal lung maturity has been documented. Modification of current management strategies could potentially decrease the incidence of late preterm births and prevent neonatal morbidity. For example, might the proportion of late preterm births that result from spontaneous PTL be decreased with tocolysis administered between 34 and 37 weeks gestation? Would expectant management of preterm PROM until 37 weeks result in reduced neonatal morbidity compared with induction at 34 weeks? Future research should be aimed at identifying the best balance between in utero and neonatal management.

Some progress has been made in preventing idiopathic preterm delivery and specific interventions have been identified to reduce the incidence of recurrent preterm birth. A randomized placebo controlled study of weekly 17 alpha-hydroxyprogesterone caproate (17P) demonstrated a significant reduction in the rate of recurrent preterm delivery (up to 37 weeks) in women with a history of prior preterm birth or preterm PROM (relative risk [RR] 0.66, 95% confidence interval [CI] 0.54–0.81) [22]. Although this study does not apply to woman who have not had a previous preterm birth, additional studies are underway to investigate potential benefits of 17P in other populations at risk for preterm delivery such as those with a shortened cervix on ultrasound. Because of limited availability and lack of provider and patient education, 17P is only recently being introduced into clinical care. Improved utilization of this treatment may help to reduce the preterm birth rate and may reduce the incidence of spontaneous late preterm birth.

Indicated late preterm delivery

In addition to PTL and PPROM, other medical and obstetric complications can arise in late preterm gestations and may warrant delivery before term. National data confirms an increasing rate of intervention for medical indications in both term and preterm pregnancies. In 1992, 29% of deliveries resulted from intervention for medical indication (defined as pregnancies induced or delivered by cesarean section without evidence of premature rupture of the fetal membranes); in 2002, this had risen to 41% [6]. Over the same period of time, the rate of intervention in the late preterm group for medical indications increased by 12%. Of pregnancies delivered for medical indications, 6.4% occurred between 34 and 36 weeks in 1992 and 7.4% occurred between 34 and 36 weeks in 2002 [6].

Hypertensive disorders are the most common medical complication of pregnancy and complicate 6% to 10% of pregnancies in the United States [23]. Several studies have reported an increased incidence of late preterm birth among women with gestational hypertension [23–25] or preeclampsia. Observed rates of late preterm birth range from 4% to 6% among women with gestational hypertension, and range from 10% to 11% among women with preeclampsia [24,25]. Unfortunately, available data do not differentiate between rates of induced preterm deliveries and the rates of spontaneous

preterm birth occurring simultaneously in this population of hypertensive women. Although is it feasible that some of the preterm births seen among women with hypertensive disorders stem from coexisting PTL or PPROM, expert opinion recommends delivery of mild preeclampsia at 37 weeks of gestation and severe preeclampsia as early as 34 weeks. Accordingly, labor inductions and cesarean deliveries performed between 34 and 37 weeks gestation in pregnancies complicated by preeclampsia iatrogenically increase the late preterm birth rate. Although worsening maternal or fetal status clearly justifies preterm delivery in cases of preeclampsia, many current obstetric practice guidelines, which suggest delivery at 34 weeks, may warrant revision as the risks of late preterm birth are better quantified.

Elective induction of labor and elective cesarean delivery

Published reports estimate that cesarean deliveries at maternal request account for 4% to 18% of cesarean deliveries in the United States. Unfortunately, US birth records do not allow more precise estimates because distinction between cesarean deliveries performed electively at maternal request and low-risk cesarean sections performed for unspecified indications are not differentiated [26]. Similarly, little data is available to determine the proportion of vaginal deliveries that result from elective induction at term versus those that result from spontaneous labor or indicated induction. Although birth records in other countries report the frequency and timing of elective deliveries, birth records in the United States do not track inductions performed at "maternal request" or cesarean sections done by "patient choice." Accordingly, it is impossible to accurately determine the proportion of births—term or preterm—that might result from elective delivery.

Although little data directly link elective labor induction and cesarean delivery at maternal request to the increased rate of late preterm births, there is ample evidence demonstrating that rates of induction of labor and cesarean delivery have increased over the same time period. In addition, data provided by the US National Center for Health Statistics demonstrates that singleton deliveries are occurring at earlier overall gestational ages. Although spontaneous and indicated late preterm births may account for some of this shift, an increasing incidence of deliveries between 37 and 39 weeks gestation could also account for the shift toward shorter average gestational lengths [6]. In fact, deliveries occurring between 37 and 39 weeks increased 19.4% between 1992 and 2002, while the percentage of pregnancies that continue beyond term decreased significantly [6]. By 2002, the average pregnancy was 38.9 weeks in length compared with 39.2 weeks in 1992 ($P < 0.001$) [6]. Over the same period of time, the rate of induction of labor has risen sharply to reach a rate of 20.6% in 2003 [27,28], and the cesarean section rate reached an all time high of 29.1% in 2004 [5]. Although many inductions and cesarean sections occur for valid indications, some are electively performed for maternal and/or practitioner convenience in the

absence of medical or obstetric indication. Increasing elective intervention in term pregnancies could account for the increasing proportion of deliveries occurring at earlier gestational ages.

Another factor potentially contributing to the increase in late preterm birth is the trend away from vaginal birth after a previous cesarean section (VBAC) and toward repeat abdominal deliveries. After years of a slowly increasing rate of VBAC, it began to fall in the mid 1990s. The VBAC rate rose steadily from 1980 to a high of 28% in 1996 and then fell to 21% in 2000, and to 10.6% by 2003 [29]. This increase in the repeat cesarean section rate increased the opportunity for iatrogenic late preterm birth.

Assuming they were performed at term, elective deliveries may have contributed to the decreasing average gestational age at delivery, but should have had minimal impact on the increasing rate of late preterm births seen over the last decades. However, because of the inherent inaccuracy of pregnancy dating with margins of error of up to 3 weeks in the third trimester, inductions of labor and elective cesarean section performed at "presumed term" might inadvertently contribute to the increasing incidence of late preterm birth. In addition, recent research has demonstrated that elective delivery of even a well-dated pregnancy at term can lead to neonatal morbidity. One study found the rate of respiratory morbidity after elective cesarean section at 37 weeks to be three times higher than seen at 39 weeks. Another large trial of women planning elective cesarean birth found the probability of admission to a NICU at 37 weeks was 11.4% and 1.5% at 39 weeks [9].

To avoid iatrogenic prematurity and to minimize the morbidity associated with elective induction of labor and elective cesarean delivery, the ACOG recommends that elective delivery should not be performed before 39 weeks gestation. Because of the inaccuracy of pregnancy dating, criteria have been outlined to determine whether a pregnancy can be considered to be at term (Box 1) [30,31]. If gestational age cannot be accurately assessed before elective delivery at term, fetal lung maturity should be demonstrated by amniocentesis. In an attempt to further decrease the morbidity associated with elective inductions and cesarean sections at term, physicians and patients need to be counseled regarding the vulnerability of late preterm infants and the potential for iatrogenic prematurity. Hospital guidelines should also be developed and enforced to ensure that elective deliveries are not performed before gestational age of 39 weeks, and that fetal lung maturity should be demonstrated when pregnancy dating cannot be confirmed before elective delivery. Based on data demonstrating the benefit of antenatal corticosteroids beyond 34 weeks, antenatal corticosteroids should be considered if amniocentesis fails to confirm fetal lung maturity and delivery is required.

Reduction of morbidity in late preterm births

Administration of antenatal corticosteroids undoubtedly reduce a number of neonatal morbidities including respiratory distress and intraventricular

Box 1. Confirmation of term gestation

- Fetal heart tones have been documented for 20 weeks by nonelectronic fetoscope or for 30 weeks by Doppler.
- It has been 36 weeks since a positive serum or urine human gonadotropin pregnancy test was performed by a reliable laboratory.
- An ultrasound measurement of the crown–rump length, obtained at 6–12 weeks, supports a gestational age of at least 39 weeks.
- An ultrasound obtained at 13–20 weeks confirms the gestational age of at least 39 weeks determined by clinical history and physical examination.

Adapted from American College of Obstetricians and Gynecologists (ACOG). Induction of Labor. Washington DC; American College of Obstetricians and Gynecologists; 1999. (ACOG practice bulletin; no. 10).

hemorrhage. However, given the low baseline risks of these complications in neonates delivered after 34 weeks of gestation, both the National Institutes of Health and ACOG recommend antenatal corticosteroid administration only for women at risk for preterm delivery at less than 34 weeks gestation [32,33]. Recent research, however, has demonstrated that corticosteroids improved neonatal outcomes even when administered later in pregnancy. The Antenatal Steroids for Term Caesarean Section study randomized women to antenatal steroids or none at the time of elective cesarean section at or beyond 37 weeks gestation and demonstrated a significant reduction in overall respiratory morbidity (including respiratory distress syndrome (RDS) and transient tachypnea) in the exposed neonates (RR 0.46; 95% CI 0.23–0.93) [9]. Given the results of this study, future research should be given to evaluating the benefits and risks of administration of antenatal corticosteroids either for spontaneous PTL or indicated iatrogenic delivery between 34 and 37 weeks of gestation.

Summary

At all gestational ages, the risks of continuing a pregnancy must be carefully balanced against the risks of delivery and the associated risk of prematurity. This concept is of increasing importance in late preterm pregnancy when medical or obstetric complications frequently warrant delivery and the risk of prematurity persists. Given that morbidity exists for infants born between 34 and 37 weeks gestation, efforts should be focused on minimizing the late preterm birth rate and at improving the outcome of these

infants. Published guidelines outlining the appropriate timing of elective induction of labor and elective cesarean section should be closely followed to avoid unintended iatrogenic prematurity. Research should continue to investigate the etiology of spontaneous preterm deliveries and aim to develop strategies of primary prevention. The incidence and etiology of iatrogenic late preterm birth should also be further investigated and alternative management strategies should be considered. To gain information about the impact of elective delivery on late preterm births, the data collected from birth records should reflect the changing obstetric practices in the United States and be revised to include specific information on elective deliveries.

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