

JOINT WORKSHOP EXECUTIVE SUMMARY

Perivable birth: executive summary of a joint workshop by the Eunice Kennedy Shriver National Institute of Child Health and Human Development, Society for Maternal-Fetal Medicine, American Academy of Pediatrics, and American College of Obstetricians and Gynecologists

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This is an executive summary of a workshop on the management and counseling issues of women anticipated to deliver at a perivable gestation (broadly defined as 20 0/7 through 25 6/7 weeks of gestation) and the treatment options for the newborn infant. Upon review of the available literature, the workshop panel noted that the rates of neonatal survival and neurodevelopmental disabilities among the survivors vary greatly across the perivable gestations and are significantly influenced by the obstetric and neonatal management practices (eg, antenatal steroid, tocolytic agents, and antibiotic administration; cesarean birth; and local protocols for perinatal care, neonatal resuscitation, and intensive care support). These are, in turn, influenced by the variations in local and regional definitions of limits of viability. Because of the complexities in making difficult management decisions, obstetric and neonatal teams should confer prior to meeting with the family, when feasible. Family counseling should be coordinated with the goal of creating mutual trust, respect, and understanding and should incorporate evidence-based counseling methods. Since clinical circumstances can change rapidly with increasing gestational age, counseling should include discussion of the benefits and risks of various maternal and neonatal interventions at the time of counseling. There should be a plan for follow-up counseling as clinical circumstances evolve. The panel proposed a research agenda and recommended developing educational curricula on the care and counseling of families facing the birth of a perivable infant.

The counseling and management of women at risk for delivering near the limit of viability, referred to in this document as the “perivable period” (broadly defined as 20 0/7 through 25 6/7 weeks of gestation), remains 1 of the most challenging issues faced by obstetricians and neonatologists. When delivery is anticipated or occurs during this period, the health care team and the family must quickly make complex, ethically challenging decisions—often in an emotionally charged and evolving setting. Such decision-making continues through the newborn infant’s hospital course in the neonatal intensive care unit (NICU).¹

Despite guidelines from professional societies regarding maternal and neonatal care at perivable gestations, many issues remain unresolved.²⁻⁴ For example: where should women at risk

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This is an executive summary of a Society for Maternal-Fetal Medicine (SMFM), Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), American College of Obstetricians and Gynecologists (the College), and American Academy of Pediatrics (AAP) Workshop that was held Feb. 12-13, 2013, in San Francisco, CA. The information and guidance herein reflects consensus regarding clinical and scientific advances as of the Workshop, is subject to change, and should not be construed as dictating an exclusive course of treatment or procedure. The information and guidance provided does not necessarily represent the official views of the National Institutes of Health, SMFM, NICHD, the College, or AAP, or the views of each individual participant in the Workshop.

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For a list of organizers, invited speakers, and discussants who participated in the workshop, see the Appendix online at <http://links.lww.com/A483>.

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for periviable birth be cared for; when should tocolytic agents and antenatal corticosteroids be given to delay delivery and to advance fetal lung maturation; when should electronic fetal monitoring be instituted to assess the fetal status; when should cesarean delivery be offered for fetal indications; how should the potential benefits to the infant and the risks to the mother from cesarean birth at a periviable gestation be balanced; when and how should the family be counseled regarding these complex issues and what should the contents of such counseling be; and when and how should decisions regarding initial or continued intensive newborn infant care vs comfort care be made?

To address these issues, the Society for Maternal-Fetal Medicine, Eunice Kennedy Shriver National Institute of Child Health and Human Development, the Section on Perinatal Pediatrics of the American Academy of Pediatrics, and the American College of Obstetricians and Gynecologists convened a joint workshop, which was held concurrently with the annual meeting of the Society for Maternal-Fetal Medicine in San Francisco, California, on Feb. 12-13, 2013. This executive summary reviews the benefits and risks of obstetric and neonatal interventions related to periviable birth, provides an outline for counseling these patients, describes newborn infant outcomes after periviable birth, and outlines research and educational agendas regarding care and treatment of these patients. Suggested treatment outlines are based on review of the available literature and extrapolation from relevant articles by the expert panel.

Definitions

There are numerous terms used to refer to preterm delivery at a very early gestational age (eg, extremely low gestational age, extreme preterm, very preterm), at a very small size (extremely low birthweight, micro preemie), of a very immature fetus (immature born, marginally viable), or near the limit of potential survival (margin of viability, border of viability, threshold of viability, periviable).⁵⁻¹³ Each encompasses a

gestational age spectrum that includes high rates of mortality and severe morbidities among survivors at the lower end and significantly higher rates of survival and survival without major disabilities at the upper end. We recognize that there is no ideal definition and that no phrase precisely reflects all components of the epidemiology and the dilemmas associated with decision-making during this time frame. We have opted for the phrase “periviable birth,” defined as delivery occurring from 20 0/7 through 25 6/7 weeks of gestation, to reflect the gestational age range in which survival rates range from 0% at 20 to >50% at 25 weeks of gestation.

Morbidity and mortality rates and ethical dilemmas

Approximately 0.4–0.5% of all births occur ≤ 27 weeks of gestation, and these account for >40% of infant deaths¹⁴ and most neonatal deaths. Infants born at 20 and 21 weeks of gestation do not survive, irrespective of resuscitation efforts. The survival data for births at 22, 23, 24, and 25 weeks of gestation (excluding infants with birthweight lower than 401 g, >1000 g, or higher than the 97th percentile for gestational age; infants with ambiguous genitalia or major anomalies; and survivors not requiring mechanical ventilation) reported from the National Institute of Child Health and Human Development Neonatal Research Network were 6%, 26%, 55%, and 72%, respectively, at initial discharge from the hospital.¹⁵ Investigators from the same network later reported an additional 2.2% of extremely low gestational age infants (<27 weeks of gestation and birthweight <1000 g) died after discharge and at <22 months of age.¹⁶ Many studies have noted that, from the mid 1980s through the late 2000s, there has been an increasing rate of survival after periviable birth.¹⁵⁻³⁰ However, survival data for periviable births from the reports published since 2000 show remarkable variability in outcomes among studies (Table 1).^{15,21,24-29} There are multiple reasons for this variation, some of which include nonmodifiable factors (eg, fetal sex and weight, singleton birth),

modifiable factors (eg, intent to intervene, antenatal corticosteroid administration, life-sustaining interventions at birth), and study design and reporting features (eg, single-center, regional, or national data; definition of mortality; inclusion of all live births vs resuscitated newborn infants vs only those admitted to a NICU; Table 2). Other factors that might affect the reported survival are local practices and protocols for withholding or withdrawing intensive care after birth.

Data regarding long-term outcomes are likewise complex. Woods et al³¹ reported the outcomes at 30 months of age for infants born ≤ 23 , at 24, and at 25 weeks of gestation in 1995 in the United Kingdom and Ireland. These authors found a progressive decline in the proportion of children with “severe” disability (Bayley Scales of Infant Development-II score ≤ 54) with increasing gestational age, ranging from 27% at 23 weeks to 19% at 24 weeks and 17% at 25 weeks of gestation. In the same cohort followed to 6 years of age, similar trends in the rates of “overall disability” (a combined measure of cognition, neuromotor function, hearing, and vision) were evident; 25%, 29%, and 18% at 23, 24, and 25 weeks of gestation, respectively.³² A recent systematic review, published since the workshop was held, evaluated long-term neurodevelopmental impairment at 4–8 years among survivors born between 22 and 25 weeks of gestation. The risk of moderate-to-severe neurodevelopmental impairment decreased 6% (95% confidence interval [CI], 1.7–10.3%) for each week gained in gestational age.³³ However, morbidities were common and the CIs for point estimates were wide: 43% (21–69%), 40% (27–54%), 28% (18–41%), and 24% (17–32%) at 22, 23, 24, and 25 weeks of gestational age, respectively. Importantly, survival after birth at 22 and 23 weeks of gestation was uncommon ($n = 12$ and $=75$, respectively). Severe neurodevelopmental impairment did not significantly decrease with increasing gestational age at birth.

When counseling parents, it is appropriate to present the data regarding

TABLE 1
Survival-to-discharge after birth at 22-25 weeks of gestation in studies published that include infants born since 2000

Authors	Time frame	Study setting	Inclusions	Exclusions	Sample size	Survival, %				
						22 wk	23 wk	24 wk	25 wk	
Donohue et al ²¹	1993-2001	Retrospective cohort, single center	Women admitted with a live fetus	None	104 (2001-2003)	31				
Petrova et al ²⁴	1998-2001	Retrospective cohort, single center	Neonatal intensive care unit admissions	Congenital malformations	114	40				
Tyson et al ²⁵	1998-2003	Retrospective cohort, multicenter	Live births	Birthweight <401g, >1000 g, or >97th percentile; ambiguous genitalia; major anomalies; survival without mechanical ventilation	4446	51				
Mehler et al ²⁷	2000-2007	Prospective cohort, single center	Live births	None	208	41	76	82	80	
Kyser et al ²⁸	2000-2009	Retrospective cohort, single center	Neonatal intensive care unit admissions	Major anomalies; birthweight <401 g or >1000 g	134	33	58	87		
Stoll et al ¹⁵	2003-2007	Retrospective cohort, multicenter	Live births	None	4160	6	26	55	72	
Lee et al ²⁹	2005-2008	Prospective cohort, multicenter state-level	Live births	Birthweight <401 g or >1000 g, or >97th percentile; major anomalies; survival without mechanical ventilation.	3048	5	28	60		

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the rate of survival and long-term disabilities separately, since the parents' perspectives and the importance they give these may be different. Physicians should recognize that the parents' views on what is a "severe" disability may be different from those of the researchers or clinicians, who traditionally report the combination of death and severe disability together. Coping with a child's behavior problem, considered a "minor" disability in the published literature, may be difficult to handle for some families, while other families may be able to adapt more readily to disabilities typically considered to be major (eg, cerebral palsy).

An appreciation of the complex issues discussed above will help health care providers to engage in counseling efforts without being biased by one's personal values and experiences. Future studies are needed to develop accurate prediction models to permit better counseling of families based on their individual risks, rather than based on gestational age alone.

Obstetric care

Ideally, all periviable births should occur in tertiary care centers with expertise in maternal-fetal medicine and the availability of the highest level of neonatal intensive care services. Maternity hospitals without such resources should develop partnerships with a tertiary care center, and the latter should maintain requisite resources, including timely availability of needed experts to care for the mother, her fetus, and the newborn infant. Protocols should be developed to clarify the processes for consultation and transfer as well as management prior to and during transfer (eg, antenatal corticosteroid administration for fetal maturation, magnesium sulfate for neuroprophylaxis, antibiotics for infection and group B streptococcus [GBS] prophylaxis).

Obstetric interventions at periviable gestations have included measures to delay delivery and to improve newborn infant outcomes when delivery is anticipated, for example: emergent cerclage, tocolytic therapy to delay delivery for antenatal steroid benefit, antibiotics for

TABLE 2

Factors that affect survival outcomes and estimates among periviable births

Variable	Effect
Data source	International, national, regional, single institution data reflect variations in regional and local practices.
Cohort selection	Postnatal transportation and exclusion of inborn newborn infants not surviving to neonatal intensive care unit admission results in inclusion of those with higher potential for survival. Inclusion of nonresuscitated infants reduces overall rates of survival. Inclusion of stillbirths reduces survival potential due to lack of resuscitation. Inclusion of anomalous infants may decrease survival estimate due to inclusion of lethal anomalies.
Gestational age assignment	In vitro fertilization and ovulation induction provide accurate gestational age assignment. Last menstrual period estimates conception on day 14. Ultrasound initially performed at <24 weeks of gestation estimates gestational age within 5-10 days.
Nonmodifiable risk factors	Race/ethnicity, plurality (singleton vs multiple gestation), sex, birthweight for gestational age all affect newborn infant survival but are not modifiable.
Modifiable obstetric practices	Antenatal interventions to improve outcomes (eg, corticosteroids, tocolysis, antibiotics, magnesium for neuroprotection, fetal monitoring, willingness to perform cesarean delivery for fetal benefit).
Modifiable neonatal practices	Initial resuscitation and care (eg, approaches to ventilation and oxygenation, nutritional support, and treatment of newborn infant infections)
Approaches to comfort care	Influenced by institutional and physician philosophies, parental wishes, and religious convictions.
Regional/hospital legal and practice guidelines	Policies concerning neonatal resuscitation; "self-fulfilling prophecy" of nonintervention/initial comfort care.

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GBS prophylaxis or to reduce infection and prolong latency after preterm premature rupture of the membranes (PROM), antenatal corticosteroids to enhance fetal maturation, and a willingness to intervene to prevent stillbirth or fetal trauma at delivery. The potential effect of these interventions on newborn infant outcomes and maternal well-being varies according to individual circumstances and with advancing gestational age.

Evidence-based data regarding obstetric interventions for those delivering at 20-25 weeks of gestation are limited, since these gestational ages were considered nonviable in the 1970s and early 1980s when many studies on these interventions for anticipated preterm births were conducted. Further, because a small number of women actually deliver at ≤ 25 weeks of gestation, most studies and metaanalyses involving these patients lack power to assess the effect of such interventions.

The workshop panel reviewed available literature and considered interventions and the levels of supporting evidence across the spectrum of periviable gestations.³⁴⁻⁵⁰ Some of these interventions pose little risk to the mother

while others impose a significant burden.

Tocolytic therapy is proposed to reduce uterine activity for the purpose of delaying delivery to increase the time for antenatal corticosteroid effects. However, data regarding currently available therapeutic tocolytic agents fail to consistently demonstrate either pregnancy prolongation beyond 24-48 hours or newborn infant benefits, and no studies specifically address women with preterm labor or PROM at 20-25 weeks of gestation.

Physical examination—indicated cervical cerclage is performed when the fetal membranes are seen to bulge to or past the external cervical os in the absence of contractions. Observational studies describe that physical examination—indicated cerclage, performed at an average gestational age of 22 weeks, can be associated with a mean pregnancy prolongation of 7-9 weeks, compared with 2-3 weeks for those treated without cerclage placement, as well as increased live birth and neonatal survival.³⁵⁻³⁸

Antenatal corticosteroid administration is one of the most effective antenatal interventions to improve infant outcomes.³⁹⁻⁴³ Lung tissue in explant culture

from 12–24-week human fetuses has been shown to respond to corticosteroids with an increase in epithelial maturation and the appearance of lamellar bodies.³⁹ Data from the *Eunice Kennedy Shriver Neonatal Research Network* observational cohort revealed death or neurodevelopmental impairment at 18-22 months to be lower for infants exposed to antenatal corticosteroids and born at 23 weeks of gestation (83.4% vs 90.5%; adjusted odds ratio [AOR], 0.58; 95% confidence interval [CI], 0.42–0.80), at 24 weeks (68.4% vs 80.3%; AOR, 0.62; 95% CI, 0.49–0.78), and at 25 weeks (52.7% vs 67.9%; AOR, 0.61; 95% CI, 0.50–0.74), but not at 22 weeks of gestation (90.2% vs 93.1%; AOR 0.80; 95% CI, 0.29–2.21).⁴⁰ Death, intraventricular hemorrhage (IVH), or periventricular leukomalacia and death or necrotizing enterocolitis were also significantly less frequent among infants born at 23, 24, and 25 weeks of gestation after antenatal corticosteroid exposure. The benefits regarding reduced death persisted through 18-22 months (OR, 0.59; 95% CI, 0.53–65) for infants born at 22-25 weeks of gestation. Similarly, Mori et al⁴¹ reported that infants exposed to antenatal corticosteroids before birth

at 24-25 weeks of gestation had less frequent respiratory distress syndrome (OR, 0.77; 95% CI, 0.60–0.98), less frequent severe IVH (OR, 0.49; 95% CI, 0.36–0.67), and lower mortality rates (OR, 0.65; 95% CI, 0.5–0.86) compared with unexposed infants at the same gestations. In fact, even among the infants born at 22-23 weeks of gestation, antenatal corticosteroid exposure decreased mortality rates (OR, 0.72; 95% CI, 0.53–0.97). In 2008, Tyson et al²⁵ estimated that antenatal corticosteroid administration increased the “functional” (in terms of maturity) gestational age of those born at 22-25 weeks of gestation by 1.1, 1.2, and 1.3 weeks for survival, death or profound impairment, and death or any impairment, respectively.

Magnesium sulfate for neuroprotection has been studied among women at risk for imminent early preterm birth in 5 randomized controlled trials, including women recruited at 24-25 weeks of gestation.⁴⁴ Overall, magnesium sulfate treatment reduced cerebral palsy (relative risk [RR], 0.68; 95% CI, 0.54–0.87) and substantial gross motor dysfunction (RR, 0.61; 95% CI, 0.44–0.85) among survivors without increasing mortality rates (RR, 1.04; 95% CI, 0.92–1.17). Similar effects were seen with administration at <30 weeks of gestation for any cerebral palsy (RR, 0.69; 95% CI, 0.52–0.92), moderate-to-severe cerebral palsy (RR, 0.54; 95% CI, 0.36–0.80), and death (RR, 1.00; 95% CI, 0.87–1.15). However, data specific to those treated at 20-25 weeks of gestation are not available.

Intrapartum antibiotic prophylaxis against GBS reduces newborn infant infection, and *antibiotic treatment during conservative management of preterm PROM* both prolongs pregnancy and reduces newborn infant infections. Studies of these interventions have included only limited numbers of women near the limit of viability and specific data for those at 20-25 weeks of gestation are lacking.

Cesarean delivery

If a decision is made to provide intensive interventions for an infant in the periviable period, a second decision is

required regarding the mode of delivery. This second decision can be divided in 2: is routine cesarean delivery appropriate for all such pregnancies? And, if not, will emergency cesarean delivery be considered to prevent trauma, stillbirth, or fetal asphyxia for specific indications? The published literature regarding cesarean delivery for periviable birth is limited by a lack of adequate data reflecting the causes, interventions, and contribution of current practices on outcomes related to cesarean delivery for periviable births.⁴⁵⁻⁴⁹ Further, randomized controlled trials of adequate size regarding planned cesarean delivery compared with planned vaginal delivery for periviable births have not been performed. Currently available data do not consistently support routine cesarean delivery to improve perinatal mortality rates or neurologic outcomes for early preterm infants.⁴⁵ There is no clear evidence that routinely performed cesarean delivery improves survival or long-term outcomes with growth restriction, and data suggesting improved outcomes with cesarean delivery for fetal malpresentation are limited.⁴⁹ Alternatively, cesarean delivery in the periviable period incurs greater maternal morbidity, both immediately postoperatively and for future pregnancies, which must be considered in the risk-benefit balance when counseling women.

Within this framework, a team approach to counseling is recommended for those presenting at ≥ 20 weeks of gestation. The use of different obstetric interventions should be based on an individual analysis of the risks and benefits. When death is anticipated, the parents should be informed about the option of termination of pregnancy if this is consistent with regional statutes. A plan for reevaluation and follow-up counseling should also be in place. Importantly, providers and families should understand that initiation of intervention to enhance outcomes (eg, antibiotics for preterm PROM, antenatal corticosteroid administration) does not mandate that all other aggressive interventions (eg, cesarean delivery) be undertaken regardless of clinical circumstances in the periviable period.

Optimally, guidance regarding perinatal management of anticipated or imminent periviable birth would be offered based on a firm knowledge of the likelihood of infant survival and a known likelihood of long-term morbidities. Gestational age alone and currently available predictive algorithms do not provide information that is sufficiently accurate or generalizable. Regardless of local or regional differences, there are substantial current data supporting that infants born ≤ 21 weeks of gestation do not survive after birth, regardless of aggressive intervention, and that most infants born ≥ 24 weeks of gestation do survive if live-born and resuscitated. Alternatively, at 22-23 weeks of gestation, most live-born resuscitated infants will not survive, and it is likely that local and other individual factors will have the greatest effect on outcomes for these infants born at the cusp of viability. In certain circumstances (eg, unknown or irregular menstrual history with late prenatal care), gestational age cannot be determined accurately. In this circumstance, gestational age is estimated based on data available when periviable birth is imminent, and the accuracy of this estimate should be considered during counseling and decision-making.

Table 3 offers guidance based on current evidence and expert opinion. In many cases, data specific to the periviable period are lacking, so guidance is offered based on extrapolation from available data regarding interventions at more advanced gestational ages. Interventions to delay delivery prior to 22 weeks of gestation may not succeed in prolongation of pregnancy. In such circumstances, it is appropriate to withhold continued intrapartum interventions for fetal benefit, neonatal resuscitation, or both, despite initiation of aggressive therapy. With delivery at <22 weeks of gestation, interventions that significantly increase maternal morbidities (eg, cesarean delivery) should be avoided, where possible, and the live-born infants should be offered comfort care. Because most newborn infants at 24-25 weeks of gestation will survive if resuscitated, efforts to prolong pregnancy, intrapartum interventions for fetal benefit, and neonatal resuscitation should generally

TABLE 3

General guidance regarding obstetric interventions for threatened and imminent periviable birth^a

Variable	Weeks of gestation ^b		
	<22 0/7	22 0/7-22 6/7	≥23 0/7
Antenatal corticosteroids	Not recommended	Consider if delivery at ≥23 0/7 is anticipated	Recommended
Tocolytics to enhance latency for potential steroid benefit	Not recommended	Not recommended unless concurrent with antenatal steroids	Consider
Magnesium sulfate for neuroprotection	Not recommended	Not recommended	Recommended
Antibiotics for preterm premature rupture of membranes to enhance latency	Consider if delivery not imminent	Consider if delivery not imminent	Recommended if delivery not imminent
Intrapartum antibiotics for group B streptococcus prophylaxis ^c	Not recommended	Not recommended	Recommended
Continuous intrapartum electronic fetal monitoring	Not recommended	Not recommended	Recommended
Cesarean delivery for fetal indication ^d	Not recommended	Not recommended	Recommended
Aggressive newborn infant resuscitation	Not recommended, comfort care only	Not recommended unless considered potentially viable based on individual circumstances	Recommended unless considered nonviable based on individual circumstances

^a Survival of infants born in the periviable period is dependent on resuscitation and support. Between 22 weeks and 25 weeks of gestation, there may be mitigating factors (eg, intrauterine growth restriction, small fetal size, the presence of fetal malformations or aneuploidy, and pulmonary hypoplasia due to prolonged membrane rupture) that will affect the potential for survival and the determination of viability (Table 2). The majority of survivors born at 25 6/7 weeks of gestation or less will incur major morbidities, regardless of gestational age at birth; ^b Infants born at <22 0/7 weeks of gestation are generally considered nonviable. Data from recent large studies suggest survival with delivery at 22 0/7 through 22 6/7 weeks of gestation to be 5-6%.^{25,27} With survival rates of approximately 26-28% and higher, infants born at 23 0/7 weeks through 25 6/7 weeks of gestation are generally considered potentially viable (Tables 1 and 2); ^c Group B streptococcus carrier or carrier status unknown; ^d For example, persistently abnormal fetal heart rate patterns or biophysical testing (category II-III).

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be offered, if appropriate. At 22-23 weeks of gestation, management decisions will need to be made based on whether the fetus is considered potentially viable based on individual clinical circumstances and whether the family desires aggressive measures to improve the potential for newborn infant survival after birth. In general, those born at 23 weeks of gestation should be considered potentially viable, as survival with resuscitation is 26-28% or more. Those considered nonviable at 22-23 weeks of gestation can be treated similarly to pregnancies at 20-21 weeks of gestation, while those considered potentially viable should be treated in a manner consistent with similar pregnancies at 24-25 weeks of gestation. If feasible, delivery of potentially viable infants should be undertaken in settings in which resources are available to care for extremely small and immature infants. This approach has the potential to increase the opportunity for survival and reduce morbidities among survivors.

Newborn infant care

Optimally, decisions regarding newborn infant resuscitation will be made after family counseling. Such counseling cannot be provided before delivery in all cases, as periviable birth often occurs emergently. Where detailed family counseling and input cannot be accomplished before delivery, follow-up counseling should be performed after initial newborn infant evaluation and care and should incorporate information available, such as the newborn infant's initial response to intervention. It is emphasized that preterm infants born in the periviable period do not survive without life-sustaining interventions after birth, regardless of obstetric interventions.

Life-sustaining interventions

It is expected that the team responsible for stabilizing the periviable infant will have successfully completed training provided by the Neonatal Resuscitation Program and be competent to implement

all of the components of the International Liaison Committee on Resuscitation neonatal guidelines.⁵¹ It is helpful to carry out simulated scenarios to make sure the processes are implemented smoothly. Elements of successful stabilization include a preresuscitation checklist to evaluate equipment functionality, clearly assigned roles and responsibilities for each person involved in newborn infant resuscitation, and adherence to the Neonatal Resuscitation Program algorithm.⁵² After stabilization, a debriefing session can provide time for self-reflection and help improve the function of the group for future resuscitations. The goal of the initial stabilization of the periviable infant is no different from that for an infant at a more advanced gestational age. However, because of extreme fetal immaturity and small size, there are special considerations (Table 4). The feasibility of enhancing placental transfusion by delaying cord clamping for up to 30 seconds should be explored.

TABLE 4
Considerations for resuscitation of the periviable newborn infant

Issue	Effect
Large surface-to-body weight ratio	Increased potential for heat loss
Weak chest wall muscles	Limited ability to breathe against high pulmonary resistance
Marked surfactant deficiency	Increased work of initial and sustained lung expansion and ventilation
Poor respiratory drive due to immature nervous system	Need for immediate respiratory support
Immature tissues more readily damaged by oxygen	Continuous monitoring of oxygen saturation to avoid hyperoxia
Small blood volume	Susceptible to hypovolemia in the event of acute blood loss
Small fat mass and hepatic energy stores	Prone to hypoglycemic episodes
Lack of keratinization, multiple access lines, intubation/ventilation, and decreased immunity	Increased potential for infection Need for frequent communication with family
Parental anxiety, often with concurrently ill mother	—

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Neonatologists, neonatal fellows, or senior respiratory therapists, if available, should intubate these newborn infants to keep the number of intubation attempts to a minimum. If effective pulmonary ventilation is established, cardiopulmonary resuscitation (CPR) is rarely needed. In 1 study, the chance of disability-free survival was only 14% in extremely low birthweight infants who attained a 5-minute Apgar score <2 after CPR in the delivery room, indicating that prolonged CPR is a marker for higher mortality rates.⁵²

Hypothermia is a major threat to the survival of a periviable newborn infant. In a cohort of >500 infants born ≤24 weeks of gestation, 72% had an admission temperature <36°C and 34% were <34°C.⁵³ For every 1°C decrease in admission temperature, the odds of late-onset sepsis increased by 11% (OR, 1.11; 95% CI, 1.02–1.20), and risk of death increased by 28% (OR, 1.28; 95% CI, 1.16–1.41). The World Health Organization and the International Liaison Committee on Resuscitation recommend that the delivery room should be at least 25°C (77°F) to prevent neonatal hypothermia.⁵⁴ Other steps include using

wool or plastic hats, wrapping with polyethylene occlusive, and using a thermal gel mattress.

The golden hours

Some experts consider the first 48–72 hours after resuscitation of extremely premature infants as “golden hours” during which infants appear to transition from intrauterine to extrauterine life. Apparent stability is often followed by deterioration, most likely due to failure of multiple organ systems and in some cases aggravated by hypothermia. Even if hypothermia is prevented in the delivery room, many periviable infants become hypothermic during transfer to the NICU, potentially compounding metabolic acidosis. The lungs of such infants may be so immature that it may be difficult or impossible to ventilate them. Over half of preterm infants at periviable gestations manifest low mean blood pressure values during the first 3 days. Since there are no evidence-based guidelines for either defining “hypotension” or its treatment, the health care team should assess the overall status of the infant prior to deciding on fluid, medication, and other interventions.

However, since physiological functions are interconnected, management of one “clinical problem” may affect others. For instance, an attempt to correct serum electrolyte imbalance might lead to fluid overload and adversely affect the respiratory and cardiovascular functions. Thus, one should plan for vigilant monitoring to assess rapidly changing physiological functions and to fine-tune management options.

The first week

Critical to the continued survival of the periviable infant are respiratory and cardiovascular support; fluid, electrolyte, and nutritional management; treatment of acid-base imbalances; and utilization of cerebral protection measures.²⁷ Periviable infants require all components of intensive care, but their needs are often more acute with a narrow margin for error. For instance, because of extreme thinness of the skin and subcutaneous tissue, there is a risk of profound water loss unless a neutral thermal temperature environment with high humidity is maintained. Slight imbalance in administered fluid volume could compromise cardiac, respiratory, and renal functions. The role of noninvasive respiratory management in improving outcomes has not been well-studied in periviable infants.

Intracranial hemorrhage is a major neurological complication in the first week of life for periviable infants. Antenatal corticosteroids are known to reduce the occurrence of patent ductus arteriosus and IVH.^{41–43,55–59} Systematic reviews and metaanalyses of the studies of prophylactic postnatal indomethacin have confirmed the significant reduction in severe IVH. In 14 trials including >2500 newborn infants, a 35% reduction in severe IVH was evident (RR, 0.66; 95% CI, 0.53–0.82; *P* < .001).⁵⁸ However, a well-conducted study of prophylactic indomethacin did not show a benefit on neurodevelopmental outcomes, despite a reduction in severe IVH (grades 3 and 4) from 13–9%.⁵⁹ The demonstrated reduction in severe IVH, serious pulmonary hemorrhage, and the need for surgical ligation of patent

TABLE 5

Considerations regarding family counseling for anticipated or inevitable periviable birth

Item	Suggested steps
General	<ul style="list-style-type: none"> • Providers should be aware of local standards (eg, hospital) and regulations (eg, state laws). • Counseling should be personalized and in the best interest of the family and their child, considering aspects beyond the gestational age. • Written guidelines should be developed by obstetric and neonatal teams with input from other stakeholders (eg, ethicists, nursing, administration, risk management, former NICU families). • Use protocols and checklists as adjuncts to proper counseling and not as “standalone” tools. • The institution should develop structured checklists and documentation processes to standardize use of counseling and obstetric and neonatal interventions, including newborn infant resuscitation. • The institution should provide for regular multidisciplinary conferences and teaching sessions.
Prior to and after counseling sessions	<ul style="list-style-type: none"> • Obstetric and neonatal care providers should confer to avoid conflicting information. • Obstetric and neonatal care providers should meet the parent(s) together if feasible. • Post-counseling debriefing should occur to share and confirm the decisions (if any). • Repeated counseling should occur as clinical circumstances change.
During counseling	<ul style="list-style-type: none"> • Provide counseling in the families’ preferred language using trained professional interpreters as needed, and use family interpreter only if the family makes such a request. • Foster informed, collaborative decision-making in an open, transparent, and supportive atmosphere. • Seek out the family’s concerns and how they can be helped.
Content of counseling	<ul style="list-style-type: none"> • Individualize the information to be provided, based on family preferences, wants, and needs. • Some will want to receive detailed statistics, while others prefer hearing only the “big picture.” • Investigate how much the family wants to be directed in their decision-making process. • Consider the use of decision aids or other materials. • Recognize that the family’s wishes may be influenced by their cultural background, religious beliefs, or both.
Specific information	<ul style="list-style-type: none"> • Provide institutional data regarding survival and disability, if available. Otherwise, share regional, national, or other population-based outcome information. • Provide information regarding available obstetric interventions, including their potential benefits and risks. • Provide information regarding the possibility of survival and disabilities separately. • Offer information regarding anticipated NICU care; provide more information about potential NICU stay according to family’s wishes: appearance of baby at birth, NICU complications, family-centered care in the NICU, provision of breast milk, etc. • Discuss options for comfort care and circumstances that might result in reconsideration of life-sustaining interventions. • Inform the family that the baby’s appearance at birth and Apgar scores are of limited prognostic value for survival and long-term morbidities. • State that infants born at extremely low gestational ages have a reduced survival and increased risks of adverse long-term outcomes. • Information given to families should include what some children cannot do because of disabilities and what many can do. • Mention adaptation and coping difficulties; the meaning of disability and the effect on families should be included.
Follow-up	<ul style="list-style-type: none"> • Offer the family time to think about the information provided and needed decisions if circumstances permit. Encourage input by prospective parents’ important supports (eg, friends, family members, faith leaders) according to family preferences.

NICU, neonatal intensive care unit.

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ductus arteriosus⁵⁹ may well be considered significant benefits by families.

Optimal nutrition is of critical importance to the periviable infant, as is the provision of human milk, which has

been shown to decrease necrotizing enterocolitis and mortality rates. Initial intravenous therapy should contain amino acids, and optimal total parenteral nutrition should be started in the

first 24 hours after birth. Mothers should be encouraged and taught to express their breast milk. Breast milk expression within 6 hours of delivery is associated with increased production and a longer

TABLE 6

Recommendations for research and education regarding counseling, and maternal and neonatal management

Topic	Research and educational opportunities
General issues	1. Reducing barriers to randomized control trials in vulnerable populations (institutional and cultural)
	2. Development of feasible methods to obtain emergency waiver of informed consent for research at periviable gestations
	3. Population-based obstetric and newborn infant cohort studies regarding the epidemiology, antecedent causes, and outcomes of periviable births, including long-term follow-up of both mothers and infants
	4. Best practices studies that assess the value of individual practices and care management bundles for mothers and babies
	5. Comparative effectiveness and quality improvement studies regarding obstetric and newborn infant treatment
	6. Increased family participation in research regarding counseling, understanding, and preferences
Obstetric issues	7. Development of accurate and precise tools for the prenatal prediction of infant death and long-term complications after periviable birth
	8. Development of improved methods for best obstetric estimation of gestational age for women with limited prenatal care
	9. Studies regarding the effect of specific obstetric interventions at periviable gestations, including:
	a. Short-term and long-term maternal morbidities
	b. Short-term and long-term newborn infant outcomes
	c. Effect of interventions on the index and future pregnancies, including long-term reproductive and genitourinary health
	d. Psychosocial effect of threatened and periviable birth and delivery of a periviable infant on the parents and the family
Neonatal care issues	10. Specific studies regarding neonatal resuscitation practices and bundles
	11. Development of team-training programs for neonatal resuscitation
	12. Study of the logistics and approaches of the timing of umbilical cord clamping and milking to maximize outcomes for the periviable infant
	13. Follow-up studies regarding neurodevelopmental and medical outcomes, including retinopathy of prematurity, chronic lung disease, and the quality of life
	14. Development of improved measures for evaluation and treatment of neurodevelopmental disabilities
	15. Studies regarding the effect of specific neonatal interventions at periviable gestations, including:
	a. Initiation and support of ventilation of the periviable infant
	b. Prevention of initial and subsequent hypothermia
	c. Cardiovascular support and the definition and management of hypotension
	d. Fluid and electrolyte management and nutritional strategies
	e. Interventions for neuroprotection
	f. Effect of the neonatal intensive care unit environment (noise, lighting, and handling issues) on newborn infant outcomes
	g. Reducing nosocomial infections (optimizing antibiotic use)
	h. Prevention of necrotizing enterocolitis
	Counseling issues
17. Inclusion of specialty-specific formal training programs regarding advanced communication skills within postgraduate education programs	
18. Development of educational material for families at risk for and experiencing a periviable birth	

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(continued)

TABLE 6

Recommendations for research and education regarding counseling, and maternal and neonatal management*(continued)*

Topic	Research and educational opportunities
	19. Studies regarding optimal family-focused counseling
	20. Studies to examine the effect of the extent and the nature of counseling on family understanding, perception, decision-making, and satisfaction
	21. Improved understanding of the effect of language and terminology used on family understanding and decision-making
	22. Improved understanding of the dynamics and effect of paternal and family input on maternal decision-making

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duration of breast milk feeding. Delay of enteral feeding for a prolonged period is no longer indicated, as early institution of trophic feeds has been demonstrated to be beneficial.

While there is intrainstitutional and interinstitutional variation regarding how the components of intensive care management for the periviable infant are administered, the effect of such practice variations on survival and morbidity rates needs to be assessed.

Counseling

The goal of family counseling regarding anticipated or imminent periviable birth is to provide objective information in a compassionate manner, to permit shared decision-making, and to support the family. While developing a standardized approach to counseling is important, there cannot be a single approach for all families. The health care team should be prepared to tailor their approach and language to family needs and preferences (Table 5).

Counseling should be a bidirectional, collaborative, and ongoing process. Often, families in crisis do not recall many key components of the counseling. Some parents only want to know “the big picture,” while others wish to receive detailed information and statistics.⁶⁰ Counseling of the pregnant woman can be directive when appropriate (Table 5).⁵⁰ Some families want to be directed in their decision-making, whereas others want to play an active role in making their own decisions. Some parents wish other family members or key

supporters to participate in the process. Counseling should continue after the birth of the infant, preferably using designated personnel to update the family during the first hours and days after delivery.

Components of counseling

Critical components in counseling will vary depending upon whether it is done before birth, after birth, or both; the likelihood of survival, and the likelihood of long-term disability. Depending upon the underlying cause of imminent periviable delivery, the discussion may include the benefits and risks of various obstetric interventions and the utility and timing of transfer to a tertiary care obstetric and neonatal facility. Discussion of the alternatives to and rationale for or against active maternal and neonatal intervention are appropriate. Institutional, regional, or national data regarding outcomes should be provided as available. Although there are visual and internet tools that augment counseling, their effect on patient satisfaction, understanding, and decision-making have not been well-studied.

Depending on circumstances, discussion of options for redirecting or withdrawing life-sustaining interventions can be brought up either at the initial meeting or at a subsequent meeting. Whenever comfort care is offered, it should be clarified that appearance at birth and Apgar scores are of limited prognostic value and that comfort care is an approach to caring for the newborn infant rather than being considered “no

care.” Health care providers should avoid statements such as “doing everything,” “the parents want nothing done,” or “there is nothing we can do.” Provision of comprehensive palliative and family-centered support is a very important aspect of medical care.

It should be emphasized that management decisions are not necessarily irrevocable. Interventions aimed at improving survival may be initiated prenatally, but a final decision to not institute life-sustaining interventions at the time of delivery can still be appropriate, particularly if the shared decision is that the predicted likelihood of newborn infant complications that may affect survival and adverse long-term outcomes is considered to be too high. The shared decision regarding management may change with time, and the team should not be “locked” into previous decisions, particularly when clinical circumstances change.

Educational needs and knowledge gaps

Table 6 outlines the recommendations for research and education developed during the workshop. While this listing is not complete, we anticipate that it can provide guidance in setting priorities for research and education regarding care and counseling regarding periviable birth.

Perhaps the most controversial aspect of the workshop, and difficult aspect of caring for a woman at risk for periviable birth and her periviable newborn infant, is the lack of highly predictive models for

infant morbidities and mortality rates. Estimated gestational age is available before birth based on menstrual dating, ultrasound, or both, but the actual conception date is rarely known. The division between 1 week and the next is an arbitrary cutoff that does not reflect continuous growth and maturation (eg, a 23 6/7-week infant and a 24 0/7-week infant [1 day discrepant] are likely more similar in size and maturity than a 23 0/7-week infant and a 24 6/7-infant [13 days discrepant]). While fetal sex, plurality, and antenatal treatments (eg, antenatal corticosteroids, magnesium sulfate for neuroprotection, antibiotic treatment) can be known with near certainty, other factors such as birth-weight can only be estimated before delivery. Similarly, the response of an individual newborn infant to resuscitative efforts cannot be reliably predicted before birth. Published long-term follow-up outcome data reflect the response of the newborn infant to interventions that may no longer be in place or may not reflect newer practices (eg, oscillator and nitric oxide ventilation therapy). While the group consensus was that counseling and treatment should optimally be based on a more refined understanding of an individual infant's likelihood of adverse outcomes, currently available predictive models using individual parameters are not known to be highly accurate. The development of accurate and precise predictive models based on ascertainable and accurate measures, which utilize updated and current outcome data, is an area of particular need. ■

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