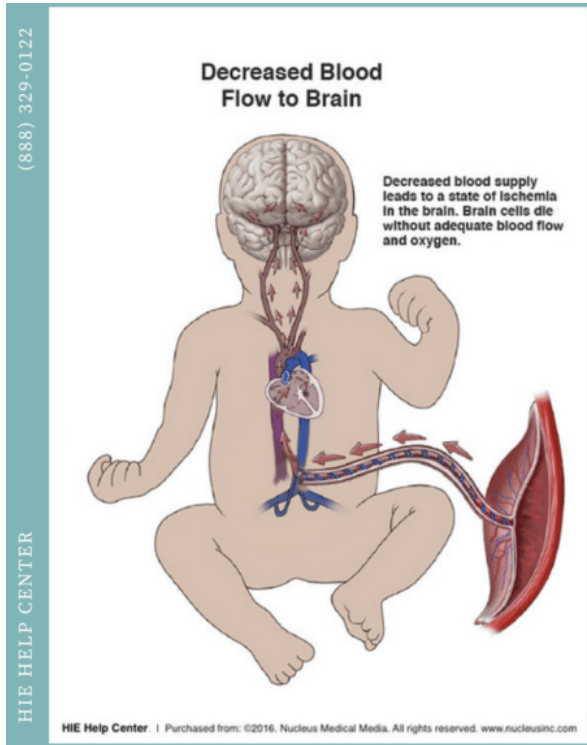




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[Hypoxic-ischemic encephalopathy \(HIE\)](#) and [associated conditions](#) (such as [cerebral palsy](#), [intellectual and developmental disabilities \(I/DD\)](#), and [seizure disorders](#)) stem from *brain damage due to oxygen deprivation*. Although adults can experience hypoxic-ischemic injury, HIE most commonly occurs as the result of an oxygen-depriving event during or around the time of birth.



## HYPOXIC-ISCHEMIC ENCEPHALOPATHY

Hypoxic-ischemic encephalopathy (HIE) is a limitation of oxygen and blood flow around the time of birth. HIE causes brain injury and can result in cerebral palsy and other cognitive and developmental impairments. Other terms used for HIE include [birth asphyxia](#), [perinatal asphyxia](#), and [neonatal encephalopathy](#).

In some instances, HIE may not be preventable. However, in most cases, oxygen deprivation occurs due to a health issue that medical staff missed or mismanaged during pregnancy, birth, or delivery. While the following is by no means a comprehensive list, it illustrates the wide variety of conditions that can cause or be risk factors for HIE.

# HIE

can be caused by any event that compromises blood and oxygen flow to the fetus.



## High-Risk Pregnancy and HIE



“High-risk pregnancy” is a general term encompassing a multitude of conditions that require



close monitoring and possible intervention. With proper medical management, women with high-risk pregnancies often deliver healthy babies. However, if medical professionals fail to recognize high-risk pregnancies and provide extra attention, the health of the mother and baby may be in danger. Conditions that make a pregnancy high-risk include (but are certainly not limited to) the following:

- Obesity
- Diabetes or gestational diabetes (when a woman develops diabetes during pregnancy)
- High blood pressure or preeclampsia (when a woman develops high blood pressure during pregnancy)
- Intrauterine growth restriction, or IUGR (small baby)
- Multiples pregnancy (twins, triplets, or more)
- Autoimmune disorders
- Use of tobacco or alcohol during pregnancy
- A mother who is under 20 or over 35
- A history of complications in previous pregnancies

Women with high-risk pregnancies should be referred to specialists who can provide extra care and check-ups to make sure that they and their babies are healthy.

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### HIE from Umbilical Cord Issues

There are many things that can be concerning in regard to the umbilical cord. Because the umbilical cord is the baby's sole source of oxygen and nutrients, it is critical that the umbilical cord function properly. If it is occluded (blocked), compressed, or knotted, this can compromise the flow of oxygen and nutrients to the baby and cause injuries.

Examples of umbilical cord issues include:

- Nuchal Cord. This is when the umbilical cord is wrapped around the baby's neck.



- Umbilical Cord Prolapse. This is when the umbilical cord exits the uterus before the baby does.
- Short Cord. When the umbilical cord is abnormally short, it may restrict the baby's movement and development, or cause the placenta to become detached from the uterine wall (placental abruption)
- True Knot. A true knot is a knot that forms in an umbilical cord.
- Infected or Inflamed Cord. If the umbilical cord becomes infected, and therefore causes decreased blood and oxygen flow, it can cause serious problems for the baby, including HIE.
- Vasa Previa. This is a condition in which blood vessels migrate out of the umbilical cord and into the membranes that lie across the birth canal. During labor and delivery, these vessels may rupture, leading to fetal blood loss and oxygen deprivation.

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### HIE From Placental or Uterine Complications

The umbilical cord is attached to the placenta, which is a dense network of capillary beds and oxygenated tissue. The placenta transports maternal nutrients and oxygen from the uterus to the umbilical cord. Issues with the uterus or placenta have the same impact as problems with the umbilical cord – compromising the flow of oxygen and nutrients will harm the baby.

Uterine and placental complications that may cause HIE include:

#### HIE from Uterine Rupture

In some rare cases, a mother's uterus may tear during delivery. This can cause the baby to move into the abdominal cavity (stretching or compressing the umbilical cord) and is accompanied by massive bleeding. This can happen when a mother attempts a vaginal birth in the presence of uterine scarring (from a prior C-section, hysterotomy, myomectomy or petroplasty). When massive bleeding occurs, the mother's blood pressure may drop and the flow of blood to the baby may dangerously decrease. Uterine rupture also often co-occurs with placental abruption, in which the placenta becomes detached from the uterus. This can also seriously limit the baby's oxygen supply. Finally, a baby may move into the mother's



abdomen following a uterine rupture, which is very dangerous because the baby's movement may cause the umbilical cord to become stretched, compressed, or torn. Uterine rupture requires delivery via emergency C-section.

### HIE from Placental Abruption

Usually, the placenta stays attached to the uterus until delivery. In a placental abruption, the placenta separates partially or completely from the uterus early. If the placenta is partially or completely detached from the uterus, oxygen and blood flow to the baby will decrease. The severity of an abruption can vary, but a mild abruption can turn severe very quickly.

### HIE from Placenta Previa

In most cases, the placenta connects to the uterus far away from the mother's cervix. With placenta previa, however, the placenta attaches to the uterus close to the cervix, which can cause life-threatening bleeding during delivery. This condition can be detected if a mother reports on-and-off bleeding during the second half of her pregnancy; doctors should be able to diagnose this using ultrasound. In some cases, a low-lying placenta migrates out of the way as the pregnancy progresses, but if it does not, the risk of HIE can be reduced by delivering via C-section. With placenta previa, the baby may also suffer from blood loss requiring an emergency blood transfusion.

### HIE from Placental Insufficiency

In some cases, the placenta can't deliver enough blood to the baby. When this happens, the baby is often diagnosed with intrauterine growth restriction (IUGR) and the mother often has oligohydramnios (low amniotic fluid). Doctors should be monitoring these pregnancies closely with non-stress tests and biophysical profiles, as well as ultrasounds to measure the baby's size, amniotic fluid levels, and placental structure. They should also conduct Doppler ultrasounds to see how blood is flowing to the baby. There are usually no obvious symptoms of placental insufficiency, but adequate monitoring should catch this condition.



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## HIE from Cervical Issues

The cervix is a structure between the uterus and vagina that normally stays closed during pregnancy. If the tissue is weakened and it opens too early (cervical insufficiency), the protective membranes surrounding the baby can bulge through this opening and rupture before the baby can survive in an outside environment. In many cases, there are no symptoms, but doctors are responsible for screening for risk factors (such as prior cervical insufficiency, a history of D&C procedures, previous traumatic birth, prior premature rupture of membranes, or uterine anomalies). If a mother has risk factors, doctors should then perform a physical exam and multiple transvaginal ultrasound studies (TVS) over time to track cervix length. Doctors can help the cervix stay long and closed using [cervical cerclage](#) or [progesterone treatment](#).

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## HIE from Oligohydramnios and Polyhydramnios

Oligohydramnios is a complication characterized by insufficient levels of amniotic fluid. Polyhydramnios is when there is too much amniotic fluid. As the baby develops, the amount of amniotic fluid tends to increase until the later parts of pregnancy, helping with nutrition and lung development. There are certain levels of amniotic fluid that are considered normal. If there is too little or too much amniotic fluid, the umbilical cord function may become compromised, increasing the risk of HIE. Doctors should be screening for amniotic fluid issues with physical examinations and ultrasound during the pregnancy.

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## HIE from Infections in the Mother or Baby

Doctors should be gathering medical histories, conducting screens and tests for certain infections, and treating the mother so the infection doesn't get passed to the baby during birth. In some cases, like when a mother has an active infection during delivery, it is imperative to give antibiotics. It may also be necessary to deliver via C-section before the



membranes rupture, so the baby is not exposed to infection via vaginal delivery. Some of these infections include:

- Chorioamnionitis and villitis
- Group B strep
- Bacterial vaginosis
- Herpes simplex virus (HSV, also known as genital herpes)

Depending on what the infection is, the baby may be diagnosed differently. The effects of neonatal infections are similar, however: infections can cause seizures, HIE, and a need for NICU admission. In many cases, adequate screening and proper prophylactic treatment (preventative measures) can stop the baby from becoming infected or stop the infection before it causes brain damage.

Diagnoses related to infection include sepsis, meningitis, encephalitis, and in some cases pneumonia. Sepsis refers to an infection that circulates through the blood and tissues, meningitis is inflammation of the membranes around the brain and spinal cord, and encephalitis is brain inflammation caused by a virus. Pneumonia is a bacterial lung infection that can cause the baby to develop breathing issues and oxygen deprivation.

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### HIE from Intrauterine Growth Restriction (IUGR)

There are certain ranges of weights that babies should be at specific times in the developmental process. If a baby isn't growing enough during pregnancy, there may be IUGR. There are numerous causes of IUGR (placental issues and underlying maternal health issues among them), and medical staff should screen for this problem. This should involve regularly-scheduled ultrasounds and other tests such as Doppler flow, weight checks, amniocentesis, non-stress tests, and biophysical profiles. Proper assessment of risk factors is critical. Once diagnosed, IUGR babies must be closely monitored and delivered early, as many of them do not fare well in labor. Lack of close monitoring and timely delivery can result in HIE.





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## HIE from Labor and Delivery Errors

There are cases in which emergency interventions are needed, both in high-risk and low-risk pregnancies. During labor, unforeseen complications require prompt responses from medical teams; failure to follow proper protocols can result in HIE. Common labor and delivery errors include:

- Not properly monitoring a baby's heart rate: It is standard practice for fetal monitoring to begin once a mother is admitted to the labor and delivery ward. This monitoring helps doctors watch the baby's heart rate – if the baby's heart rate drops or is non-reassuring, it may mean the baby is having fetal distress, which can lead to HIE. Monitoring requires staff to be able to recognize and properly read heart tracings; if medical personnel fail to recognize signs of distress or respond quickly enough, it is likelier that a baby will suffer HIE.
- Failing to prevent a preterm birth: Premature birth is a known risk factor for HIE, as premature babies are not done developing yet, making their brains more fragile and susceptible to injury. There are interventions that doctors should perform to help prevent premature birth. These interventions include:
  - Using a cervical cerclage if there is cervical insufficiency.
  - Treating a pregnancy with multiple gestations (twins, triplets, etc.) as a high-risk pregnancy and monitoring the pregnancy closely. Often, doctors recommend early delivery, usually via C-section, though induction can be an option as well.
  - If a mother has a history of preterm birth or has risk factors for preterm birth, she can receive progesterone treatment to prolong the pregnancy. Progesterone treatment is only effective in women with a singleton pregnancy, not with twins or triplets, etc.
- Failing to properly manage premature rupture of membranes (PROM): PROM occurs if a mother's membranes rupture ('water breaks') more than 18 hours before labor starts. This can pose a risk for HIE and other birth injuries because the amniotic fluid that protects the baby from infection is gone. Doctors should administer antibiotics to decrease the risk of



infection; in many cases, these babies need to be delivered via C-section because of the high risk of infection-related complications and umbilical cord compression issues. Doctors can also administer [corticosteroids](#) to mature the baby's lungs if they are preterm. An important part of preventing PROM (and premature PROM, or PPRM, which is when the membranes rupture prior to 37 weeks of gestation) is screening for infections.

- Prolonging a pregnancy for too long: If a baby is not born after 40 weeks, this may be considered a post-term pregnancy (exact definitions vary). After around 37 weeks, the placenta starts to break down in preparation for delivery. Usually, this is not a problem, but if a baby gestates for too long, it can be exposed to hypoxic (low-oxygen conditions) as the placenta continues to deteriorate, and the baby may develop post-maturity syndrome.
- Prolonging labor and delivery for too long: While every pregnancy is different, and, therefore, the length of labor is different, there are certain indicators that medical personnel look for to see if labor is progressing normally. If labor is stalled, some medical interventions might be necessary to help the mother deliver the baby safely.
- Traumatic birth: During birth, babies have mechanical force exerted on their bodies. This can be from a mother's uterine contractions, maneuvers performed by medical personnel, or the use of assistive equipment such as forceps or vacuum extractors. Traumatic birth occurs when a baby is injured in the birthing process due to too much mechanical force. There are many reasons why a birth might be traumatic, but some of the most common include the following:
  - Attempts at vaginal delivery when the baby is in a face or breech position, is too big to fit through the mother's pelvis, or has a shoulder stuck on the mother's pelvic bones.
  - Excessive uterine contractions stimulated by induction drugs
  - Improper technique when using forceps or a vacuum extractor
- Attempting to continue a vaginal delivery if a baby cannot easily fit through the birth canal: For example, a baby may have macrosomia (a condition in which they are unusually large) or there may be cephalopelvic disproportion (the baby's head is too large to fit through the mother's pelvis). In these situations, vaginal delivery carries a high risk of shoulder dystocia and traumatic birth. If there is known macrosomia or cephalopelvic disproportion, doctors should move onto a C-section. Waiting too long can cause HIE.



- Attempting a vaginal delivery when the baby is positioned in a face-first or breech position: Usually, a baby is delivered head-first. If a baby is delivered with their face pointing outward first, or feet-first, it is more likely that they will have a traumatic birth or have an umbilical cord prolapse or compression. While there are methods of attempting to shift the baby, it is often recommended that these babies be delivered via C-section.
- Making mistakes in administering medication: Cytotec and Pitocin are often used to increase the strength of contractions and speed up labor. Both of these carry risks of hyperstimulation, where the uterus contracts too hard or too fast, potentially restricting the flow of oxygen to the baby. Additionally, the use of these drugs is associated with uterine rupture – if a woman has had prior C-section or other uterine surgery, the contractions can become intense enough to cause uterine rupture, which can cause hemorrhaging that compromises blood flow to the baby.

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### HIE from Neonatal Health Mismanagement

Babies can develop health issues after birth that require proper intervention. If intervention is done incorrectly, or is delayed, the impact of these health issues can become much worse. In many cases, however, these complications can be avoided with proper monitoring and adherence to standards of care. These health issues include:

- Neonatal breathing problems: Babies who have gone through a difficult birth can sometimes need help breathing. If they are born not breathing at all, they are resuscitated, first with positive pressure ventilation (PPV), and then, if the procedure is not successful, with several alternatives in an attempt to get the baby breathing again. If resuscitation does not work, they are placed on a breathing machine called a ventilator. Medical staff must be able to place the tube properly, or they risk the baby not having air delivered to the lungs at all, along with stomach tears and lung collapse. Medical staff also have to regulate the pressure of the gases being passed into the baby's lungs or the baby can be at risk of the lungs getting too distended and injured to work (pneumothorax). This type of lung injury can severely impact the baby's ability to deliver oxygen to its tissues.



Blood acidity and oxygen saturation are important metrics, as low pH and low oxygen saturation can indicate that the baby is still not getting enough air. These are indicators that the ventilator is over-ventilating (removing too much carbon dioxide from the baby's blood). This can cause lung collapse and hypocarbia (low CO<sub>2</sub> levels), which in turn cause HIE and an injury called periventricular leukomalacia (where the baby's brain tissue starts to die and 'soften' around the periventricular area). This can in turn cause brain bleeds and hydrocephalus, where cerebrospinal fluid leaks into the ventricles, enlarging them and interfering with the development of the cerebral cortex. This impairs the development of the growth of the cerebral cortex, a key part of the brain needed for memory, attention, cognition, thought, and consciousness.

- Improper treatment of meconium aspiration syndrome (MAS): If a baby has MAS, it is an emergency. In MAS, the baby inhales particles of his or her stool during labor. This has the potential to block airways, decrease oxygen to the baby's brain, and cause infection and pneumonia. Babies with respiratory distress and MAS are admitted to the NICU, and are treated with some combination of airway clearance, ventilation, supplemental oxygen, surfactant therapy, steroid therapy, nitric oxide, ECMO or radiant warmer to maintain their body temperature, depending on the severity of the baby's respiratory distress. If the baby's MAS is not treated properly, they may suffer from HIE due to oxygen deprivation.
- Improperly treating jaundice and kernicterus: Babies can develop yellow skin, poor feeding, and lethargy due to the increased concentrations of bilirubin (a product of the breakdown of red blood cells) after birth. Babies can need some help in safely removing this bilirubin, especially if it develops in the first 24 hours after birth or between days 3-7 of life. Medical staff place the babies under special blue lights or under a fiber optic blanket in a process called phototherapy. This is a noninvasive and easy treatment which should prevent jaundice from getting worse. If the bilirubin level becomes too high, exchange transfusions will be needed. If the jaundice isn't recognized in time or the proper treatment is not given, bilirubin can cross the blood-brain barrier and cause kernicterus, a form of brain damage, which often overlaps with HIE.
- Improper treatment of neonatal hypoglycemia: It is critical that babies' blood sugar never drop too low. A baby's developing brain depends exclusively on glucose for energy. Low blood sugar levels can cause brain cells to die, causing brain bleeds and HIE. This is one of



the most common neonatal health issues, and one of the most easily solved.

Hypoglycemia can occur due to:

- Too much insulin (a disorder called PHHI)
- Intrauterine growth restriction (when the baby is small for their gestational age)
- Premature birth
- Abnormally high body temperature (hyperthermia)
- Abnormally high red blood cell mass (polycythemia)
- Sepsis (bloodstream infection)
- Growth hormone deficiency
- Dysfunctions in the glucose generation or breakdown pathways
- Depleted glycogen levels (due to oxygen deprivation or starvation)

If a baby is at risk for hypoglycemia or shows signs of hypoglycemia, blood glucose concentration must be determined within minutes (ideally via lab testing, but with a testing strip later confirmed with lab results if lab results cannot be processed quickly).

Hypoglycemia can be solved with extra feedings of breastmilk or formula. If blood glucose levels are extremely low, the baby may also be given glucose solution via IV. Treatment can last up to a week (or until the baby can maintain normal glucose levels); it can take longer in premature babies, those with infections, or those with low birth weight. Continued low glucose can require further specialized treatment.

Do you need someone to talk to?

Your child was just diagnosed with HIE and your head is spinning with what may feel like a thousand different things. Questions, medical terms, care plans; it can be difficult to make sense of everything that has happened.

As you start to do your research on exactly what your child's diagnosis means, you may be bombarded with facts, information, and advice regarding HIE, and you may be lost as to where to turn next.



We want to hear your story. HIE Help Center is owned by ABC Law Centers (a birth injury law firm). The intake team at ABC Law Centers is here to listen to every detail of what you and your family may have gone through during labor and delivery. Although we are not doctors and cannot provide medical advice, our team can provide you with resources specifically tailored to your situation. Our team has reviewed and handled thousands of cases and is trained to recognize if there may have been medical malpractice that lead to your child's diagnosis, and we can advise if taking legal action may be beneficial to you and your family.

Call us at (888) 329-0122 to speak with a member of our intake team.