



Birth Trauma in Maternal and Neonatal Emergency Management for Paramedics, Epidemiologists, Trauma Specialists, and Nursing Teams-An Updated Review

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Abstract

Background: Birth trauma is a multifactorial condition involving physical and psychological injuries to the mother and neonate during labor and delivery. It remains a significant contributor to short- and long-term morbidity worldwide. **Aim:** To provide a comprehensive synthesis of maternal and neonatal birth trauma, including risk factors, clinical manifestations, complications, and preventive strategies across multidisciplinary healthcare settings. **Methods:** A narrative synthesis approach was used to review evidence on maternal physical injuries, neonatal trauma, intracranial and extracranial hemorrhages, brachial plexus injuries, and psychological sequelae. Emphasis was placed on epidemiological trends, clinical classification, diagnostic approaches, and interprofessional management strategies. **Results:** Findings demonstrate that maternal injuries are primarily perineal lacerations associated with pelvic floor dysfunction, urinary and fecal incontinence, and sexual dysfunction. Neonatal injuries include scalp lesions, skull fractures, intracranial hemorrhages, and nerve injuries such as brachial plexus palsies. Psychological trauma affects a substantial proportion of birthing individuals, with PTSD symptoms reported in up to 12.3% and traumatic perception in up to 50%. Risk factors include fetal size, malpresentation, operative delivery, obstetric complications, and psychosocial vulnerability. Preventive strategies require coordinated antenatal risk assessment, skilled intrapartum management, and postpartum surveillance. **Conclusion:** Birth trauma remains a preventable yet significant clinical challenge requiring integrated obstetric, emergency, neonatal, nursing, and public health approaches to optimize outcomes.

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Introduction

Birth trauma represents a multidimensional clinical condition that includes both physical injury and psychological harm occurring during labor and delivery, affecting either the birthing individual, the neonate, or both. The concept extends beyond visible somatic injury and includes the broader spectrum of physiological stress responses and mental health sequelae associated with childbirth. While clinical attention has traditionally focused on observable physical complications, the intrapartum and immediate postpartum period constitutes a highly stressful biological and psychological transition capable of producing significant emotional dysregulation and long-term psychiatric morbidity. The interaction between physical injury and psychological distress is increasingly recognized as a key determinant of maternal and neonatal outcomes, requiring integrated clinical attention across obstetric, emergency, and neonatal care systems [1].

Maternal Birth Trauma

Maternal physical trauma during childbirth is most commonly represented by perineal injuries, which remain highly prevalent in vaginal deliveries. These injuries occur in a substantial proportion of births, with reported rates reaching up to 90%, reflecting the mechanical and anatomical stresses imposed on pelvic tissues during fetal passage. Perineal lacerations are clinically classified according to severity, ranging from first-degree injury involving only the vaginal mucosa to fourth-degree injury extending through the vaginal epithelium, perineal musculature, anal sphincters, and rectal mucosa. Although surgical repair is routinely performed, the aftermath of these injuries frequently includes persistent pain, sexual dysfunction such as dyspareunia, disturbances in pelvic floor integrity, and adverse psychological responses [1]. Severe obstetric trauma involving third- and fourth-degree lacerations is specifically associated with injury to the anal sphincter complex and pelvic support structures, including the levator ani musculature. These injuries are collectively described as obstetric anal sphincter injuries and are strongly correlated with long-term dysfunction of the pelvic floor. Clinical consequences include urinary incontinence, fecal incontinence, and pelvic organ prolapse, all of which contribute to chronic morbidity and reduced quality of life [2]. Beyond the physiological burden, these conditions may significantly impair maternal functional capacity, particularly in the early postpartum period when caregiving demands are highest. The resulting limitations can interfere with newborn care, maternal recovery, and may negatively influence intimate relationships and long-term reproductive health outcomes. In addition to somatic injury, maternal birth trauma includes a significant psychological component. Mental health outcomes such as posttraumatic stress disorder, postpartum depression, anxiety disorders, and acute stress reactions are increasingly recognized as critical consequences of traumatic childbirth experiences [3]. These psychological conditions often coexist with physical injury, suggesting a bidirectional relationship between somatic trauma and emotional distress. Risk factors include emergency interventions, perceived loss of control during delivery, inadequate communication, and prior psychiatric vulnerability. The consequences extend beyond the individual, influencing maternal-infant bonding, caregiving behaviors, and family system stability. The persistence of psychological symptoms may also contribute to chronic mental health disorders if not identified and managed early within postnatal care frameworks.

Neonatal Birth Trauma

Neonatal birth trauma encompasses a diverse range of injuries sustained during the mechanical forces of labor and delivery. These injuries vary in severity and may involve superficial soft tissue damage or more serious neurological and vascular complications. Common presentations include cranial injuries, intracranial and extracranial hemorrhages, and peripheral nerve injuries such as brachial plexus damage. These conditions must be clinically differentiated from congenital anomalies, as birth trauma is directly attributable to intrapartum mechanical stress rather than developmental abnormalities. Early postnatal assessment remains essential for accurate diagnosis and timely intervention, particularly in cases where neurological impairment is suspected. Over recent decades, the incidence of birth-related trauma has demonstrated a consistent downward trend, largely attributable to advancements in obstetric care and changes in delivery practices. Increased utilization of cesarean delivery has played a significant role in reducing mechanical birth injuries, particularly in cases where labor dystocia or fetal distress would previously have necessitated operative vaginal delivery using forceps or vacuum extraction. Epidemiological data indicate a reduction in birth trauma rates from 2.6 to 1.9 per 1,000 live births between 2004 and 2012, reflecting improved clinical decision-making and procedural safety [4]. This decline parallels a broader shift in obstetric practice characterized by reduced reliance on instrumental vaginal delivery and a corresponding increase in surgical delivery rates over the past several decades.

Issues of Concern

Risk factors associated with birth trauma are multifactorial and can be categorized into fetal, maternal, and iatrogenic contributors. These factors interact in complex ways during labor and delivery, influencing the likelihood of both

physical injury and psychological sequelae. Physical trauma is often linked to mechanical stressors and obstetric interventions, while psychological trauma is shaped by a broader psychosocial framework that spans antenatal, intrapartum, and postnatal periods. Understanding these risk domains is essential for prevention strategies and for improving maternal and neonatal outcomes across clinical settings [5][6].

Physical Birth Trauma

Physical birth trauma arises primarily from biomechanical stress during labor and delivery, with risk factors distributed across fetal and maternal domains, as well as procedural or iatrogenic influences. Fetal and pregnancy-related determinants include macrosomia, where increased fetal size contributes to mechanical difficulty during vaginal delivery, and macrocephaly, which increases the risk of obstructed labor and soft tissue injury. Conversely, very low birth weight and extreme prematurity also elevate risk due to tissue fragility and reduced structural resilience during delivery. Congenital anomalies may alter fetal positioning or biomechanics, further increasing susceptibility to injury during passage through the birth canal. Abnormal amniotic fluid volume, such as oligohydramnios, can reduce cushioning effects, while malpresentation including breech, face, brow, or transverse lie significantly increases the likelihood of traumatic delivery due to non-optimal fetal alignment [7]. Maternal factors also play a significant role in predisposing to physical birth trauma. Obesity is associated with increased obstetric complications, prolonged labor, and higher rates of instrumental delivery, all of which elevate trauma risk. Preexisting medical conditions such as diabetes and hypertension contribute to fetal overgrowth, placental dysfunction, and labor complications, while similar conditions diagnosed during pregnancy further complicate intrapartum management. Cephalopelvic disproportion, where fetal size is incompatible with maternal pelvic dimensions, remains a major cause of obstructed labor and traumatic delivery. Small maternal stature similarly increases mechanical constraints during childbirth. Nulliparity is another recognized risk factor, as first-time mothers are more likely to experience prolonged labor and require intervention. Labor dystocia, characterized by abnormal or prolonged progression of labor, significantly increases the likelihood of operative intervention and associated trauma. Additionally, both prolonged and precipitous labor can disrupt normal physiological adaptation, increasing mechanical stress on both maternal and fetal tissues [7]. Iatrogenic factors represent a critical component of physical birth trauma risk. The use of operative vaginal delivery techniques, including vacuum extraction and forceps application, is strongly associated with neonatal injury due to direct mechanical forces applied to the fetal head and body. These interventions, while often life-saving, increase the likelihood of cranial, soft tissue, and nerve injuries when not carefully indicated or executed. Clinical decision-making regarding these procedures must balance maternal and fetal risks, particularly in prolonged or complicated labor scenarios where urgent delivery is required.

Psychological Birth Trauma

Psychological birth trauma is influenced by a distinct but overlapping set of risk factors that extend beyond physical obstetric complications. These factors are best understood temporally across antenatal, intrapartum, and postnatal phases, reflecting the cumulative psychological burden associated with pregnancy and childbirth. Antenatal risk factors include preexisting mental health conditions such as depression and anxiety, which significantly increase vulnerability to traumatic interpretations of childbirth experiences. Fear of childbirth is another major predictor, often associated with heightened anxiety, avoidance behaviors, and negative expectations of labor. Poor maternal physical health during pregnancy can contribute to increased stress and reduced coping capacity. A history of trauma or sexual abuse is strongly associated with increased sensitivity to perceived loss of control or bodily violation during delivery. Adverse childhood experiences further compound psychological vulnerability by affecting emotional regulation and stress response systems. Lack of social or familial support contributes to isolation and reduced resilience during pregnancy, while housing instability and financial insecurity add significant psychosocial stress. Maternal substance use disorders and preexisting psychiatric conditions further increase risk by impairing coping mechanisms and emotional stability [8][9].

Intrapartum factors play a critical role in shaping psychological outcomes. Preterm delivery may be perceived as unexpected or distressing, particularly when associated with neonatal complications. Subjective negative birth experiences, characterized by feelings of fear, helplessness, or lack of autonomy, are strongly associated with psychological trauma, regardless of clinical outcomes. Operative births, including vacuum or forceps-assisted deliveries, may contribute to trauma when experienced as invasive or uncontrolled. Obstetric complications such as neonatal injury, stillbirth, emergency cesarean section, or severe maternal morbidity including intensive care unit admission, preeclampsia, hemorrhage, or sepsis significantly increase psychological distress. Lack of emotional or informational support during labor further intensifies vulnerability, particularly when communication is inadequate or fragmented. Dissociative states during childbirth, often triggered by extreme stress or pain, are also associated with later development of posttraumatic stress symptoms. Postnatal factors contribute to the persistence and exacerbation of psychological birth trauma. Postpartum depression is a major risk factor, often coexisting with trauma-related symptoms and impairing maternal functioning. Physical complications such as postpartum hemorrhage, perineal lacerations, and cesarean wound complications add to psychological burden by prolonging recovery and reinforcing negative birth perceptions. Poor coping mechanisms and chronic stress further reduce psychological resilience during

the postpartum period. Continued lack of social, familial, or healthcare support contributes to isolation and delayed recovery. Housing instability and financial difficulties remain significant stressors after delivery, while maternal substance use disorders may worsen or emerge as maladaptive coping strategies in response to unresolved trauma.

Clinical Significance

Maternal Physical Birth Trauma

Maternal physical birth trauma represents a major source of short-term morbidity and long-term functional impairment following vaginal delivery, with perineal lacerations being the most frequent obstetric injury. These injuries occur in a large proportion of vaginal births, reaching up to 90%, and are more commonly observed in nulliparous individuals due to reduced tissue elasticity and limited prior cervical and perineal stretching. The clinical importance of these injuries lies not only in their high prevalence but also in their graded severity and associated complications, which range from mild mucosal disruption to extensive damage involving the anal sphincter complex and pelvic floor musculature. Perineal lacerations are classified into four degrees based on anatomical depth and tissue involvement. First-degree tears involve only the vaginal epithelium and superficial perineal skin, while second-degree tears extend into the vaginal mucosa and underlying pelvic floor muscles. Second-degree lacerations are the most commonly encountered form in clinical practice. Despite being considered less severe than higher-grade injuries, they carry substantial clinical consequences. Evidence demonstrates that second-degree tears are associated with a significantly increased risk of stress urinary incontinence, particularly within the first year postpartum. One study reported that approximately 31% of women experienced stress urinary incontinence following childbirth, with second-degree laceration identified as the primary contributing risk factor [10]. This highlights the functional importance of even moderate perineal injury in disrupting pelvic floor integrity and continence mechanisms. Higher-degree lacerations, specifically third- and fourth-degree injuries, involve disruption of the external and internal anal sphincters and may extend to the rectal mucosa. These injuries are collectively categorized as obstetric anal sphincter injuries and are associated with more severe and persistent complications. The clinical burden of OASI is substantial, as it directly affects anorectal function and pelvic support structures. Anal incontinence has been reported in approximately 10% to 14% of affected patients within the first year postpartum [11]. Long-term outcomes are even more concerning, with one study demonstrating that up to 58% of individuals who sustained third- or fourth-degree tears reported persistent anal incontinence over time [12]. These findings emphasize the chronic nature of pelvic floor dysfunction following severe obstetric trauma and the need for long-term follow-up and rehabilitation strategies.

Sexual health outcomes are also significantly affected by perineal trauma. Dyspareunia, or painful sexual intercourse, is a frequent complication that impacts quality of life and intimate relationships. Its prevalence varies according to injury severity, occurring in approximately 31% to 41% of individuals with first- and second-degree tears, and increasing to approximately 62.5% in cases of obstetric anal sphincter injury [10]. These outcomes demonstrate that both minor and severe perineal injuries contribute to long-lasting sexual dysfunction, reinforcing the importance of preventive and reparative strategies in obstetric care. Preventive approaches to reduce the incidence of perineal lacerations remain an important clinical focus; however, no single universally effective method has been established. Intrapartum techniques such as manual perineal protection, careful control of fetal head delivery, and minimizing the use of operative vaginal delivery instruments including forceps and vacuum devices have been associated with reduced rates of severe perineal injury. These strategies aim to reduce mechanical stress on the perineum during the final stage of labor. In selected cases, mediolateral episiotomy may be performed as a controlled surgical incision intended to reduce the risk of spontaneous severe lacerations. This procedure involves an incision at approximately a 45-degree angle from the vaginal opening, typically extending 3 to 4 cm and involving the vaginal epithelium as well as deeper muscular layers such as the transverse perineal and bulbocavernosus muscles. While mediolateral episiotomy can reduce the incidence of third- and fourth-degree tears and obstetric anal sphincter injury, it is not without complications. Notably, it is associated with an increased risk of dyspareunia, highlighting the trade-off between preventing severe trauma and preserving long-term sexual function [10]. Standardized surgical repair of perineal lacerations and obstetric anal sphincter injuries remains a critical component of post-delivery management. Proper anatomical reconstruction is essential to restore pelvic floor integrity, reduce the risk of chronic complications, and improve functional outcomes. Early recognition and appropriate repair techniques are directly linked to reduced long-term morbidity, including urinary and fecal incontinence. The clinical significance of maternal physical birth trauma therefore extends beyond immediate obstetric care and requires an integrated approach involving acute management, long-term rehabilitation, and multidisciplinary follow-up to optimize maternal health outcomes.

Maternal Psychological Birth Trauma

Maternal psychological birth trauma represents a significant and increasingly recognized public health concern that extends beyond the immediate perinatal period and affects long-term mental health, family functioning, and child development. Exposure to adverse or distressing childbirth experiences places birthing individuals at heightened risk for a spectrum of psychiatric conditions, including postpartum depression, anxiety disorders, adjustment disorder, and posttraumatic stress disorder. These conditions may arise independently or coexist, reflecting the complex interaction between biological vulnerability, psychosocial stressors, and obstetric experiences. The psychological response to

childbirth is not uniform and is influenced by both objective clinical events and subjective interpretation of the birth experience, making it a multifaceted phenomenon requiring comprehensive assessment and management [13]. Epidemiological evidence highlights the burden of postpartum posttraumatic stress disorder and subthreshold trauma-related symptoms. A recent meta-analysis and systematic review encompassing 154 studies reported that the pooled prevalence of full diagnostic criteria for PTSD among birthing individuals was approximately 4.7%. In the same analysis, posttraumatic stress symptoms without full diagnostic threshold were observed in 12.3% of participants, indicating a broader spectrum of trauma-related psychological distress. These findings suggest that while clinically defined PTSD may affect a smaller proportion of individuals, a substantially larger group experiences clinically meaningful symptoms that may still impair functioning and quality of life. Earlier studies further expand this understanding, reporting that up to 50% of women describe their childbirth experience as traumatic and exhibit at least some PTSD-related symptoms, underscoring the discrepancy between formal diagnosis and subjective traumatic perception [3].

The development of maternal psychological birth trauma is influenced by a range of identifiable risk factors. Clinical and psychosocial characteristics significantly increase vulnerability to PTSD following childbirth. These include exposure to objectively traumatic birth events, preexisting fear of childbirth, and complications such as preterm delivery. Neonatal outcomes also play a critical role, particularly when infants require admission to the neonatal intensive care unit, which is often perceived as a marker of severity and loss of control. Emergency obstetric interventions, including unplanned cesarean section, are strongly associated with increased psychological distress due to the abrupt deviation from expected birth plans and heightened perception of danger. Severe adverse outcomes such as stillbirth further intensify trauma risk by introducing bereavement-related psychological processes. Maternal pregnancy complications, belonging to ethnic minority groups, and a personal history of trauma are additional contributing factors that reflect both biological vulnerability and social determinants of health [14]. The diagnostic framework for PTSD and related psychiatric conditions is defined by standardized criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. Core symptom clusters include intrusive phenomena such as recurrent distressing memories, nightmares, or flashbacks of the traumatic event. Hyperarousal symptoms involve heightened physiological and psychological reactivity, including irritability, sleep disturbance, and exaggerated startle responses when exposed to trauma-related cues. Negative alterations in cognition and mood may manifest as persistent negative beliefs, emotional numbness, or distorted self-perception. Avoidance behaviors are also central to the disorder, characterized by deliberate efforts to avoid reminders of the traumatic experience, whether internal or external. A key diagnostic requirement is that these symptoms result in clinically significant distress or functional impairment in social, occupational, or other important domains of life. Further clinical detail regarding diagnostic criteria and management frameworks is available in specialized psychiatric references [15].

The consequences of birth-related PTSD extend across multiple dimensions of maternal and family health. One of the most significant impacts is disruption of maternal-infant bonding and attachment, which is essential for early emotional development and secure caregiving relationships. Psychological distress can interfere with breastfeeding initiation and continuation, further affecting neonatal nutrition and immunological protection. PTSD may also influence reproductive decision-making, with affected individuals more likely to request elective cesarean delivery in subsequent pregnancies due to fear of recurrence of traumatic experiences. Beyond reproductive health, chronic PTSD can contribute to relational difficulties, including impaired intimacy, family conflict, and a diminished sense of identity and parental confidence. In severe cases, it may contribute to suicidal ideation, representing a critical concern for maternal safety. Evidence also suggests intergenerational effects, as children of mothers with PTSD may experience increased sleep disturbances, emotional dysregulation, and impaired developmental outcomes, highlighting the broader public health implications of untreated maternal trauma [3][15]. Management of maternal psychological birth trauma requires a multidimensional and staged approach that integrates prevention, early identification, and targeted intervention. Primary prevention strategies focus on minimizing modifiable risk factors during pregnancy and childbirth, including improving communication, informed consent processes, and emotional support during labor. One commonly discussed intervention is postpartum debriefing, which involves structured discussion of the birth experience. Although a 2015 meta-analysis of seven studies involving more than 1,700 participants found no significant reduction in PTSD symptoms with routine debriefing, evidence suggests that targeted debriefing for individuals who subjectively perceive their birth as traumatic may provide psychological benefit and improve emotional processing [16][17][18][19].

Secondary prevention and treatment strategies include evidence-based pharmacological interventions and psychotherapeutic approaches. Cognitive behavioral therapy and trauma-focused therapies are commonly utilized to address maladaptive thought patterns, intrusive symptoms, and avoidance behaviors. Pharmacological treatment may be indicated in moderate to severe cases, particularly when comorbid depression or anxiety is present. Early postpartum psychological interventions, implemented within days or weeks after delivery, have demonstrated effectiveness in reducing symptom severity and preventing chronicity, emphasizing the importance of timely recognition and referral [20]. Trauma-informed care has emerged as a central framework for addressing maternal psychological birth trauma across healthcare systems. This approach is grounded in the principles of the “4 R’s,” which include realization of the widespread impact of trauma, recognition of signs and symptoms, responsive clinical

practice, and active prevention of retraumatization. Implementation of trauma-informed care throughout antenatal, intrapartum, and postnatal services fosters a healthcare environment that prioritizes psychological safety, patient autonomy, and respectful communication. This model is particularly important in obstetric care, where patients may have limited prior interaction with healthcare systems and where vulnerability is heightened by the physiological and emotional demands of childbirth. Consistent application of trauma-informed principles creates opportunities for early identification of at-risk individuals and supports the development of integrated care pathways aimed at reducing both acute distress and long-term psychiatric morbidity.

Neonatal Physical Birth Trauma

Neonatal physical birth trauma encompasses a wide spectrum of injuries that occur during labor and delivery as a result of mechanical forces acting on the fetus. Clinical outcomes and prognosis are strongly determined by the type of injury, its anatomical location, and the presence of associated complications such as neurological involvement or vascular compromise. The most commonly affected anatomical regions include the head, neck, and shoulders, reflecting their vulnerability during passage through the birth canal. Less frequently, trauma may involve the facial structures, abdomen, and lower extremities, particularly in cases of malpresentation, prolonged labor, or operative vaginal delivery. Head injuries represent the most clinically significant category due to their potential for intracranial extension and long-term neurodevelopmental consequences. Neonatal head trauma can manifest in several forms, ranging from superficial soft tissue injuries to more severe conditions such as extracranial hematomas, intracranial hemorrhages, and fractures of the cranial bones. These injuries often require careful clinical evaluation immediately after birth, as early identification is critical for preventing secondary complications. The severity of outcomes depends on whether the injury remains localized or extends to involve intracranial structures, which may result in neurological impairment, seizures, or long-term developmental delay. Differentiation between minor and severe forms of head trauma is essential in guiding management decisions and determining the need for imaging or specialist intervention. Caput succedaneum is one of the most frequently encountered benign neonatal scalp conditions associated with birth trauma. It is characterized by diffuse, soft, and poorly defined edema of the scalp that develops as a result of sustained pressure on the presenting fetal head during delivery. The pathophysiological mechanism involves localized venous congestion leading to subcutaneous fluid accumulation between the skin and the periosteum. A key distinguishing feature of caput succedaneum is that the swelling crosses suture lines, as it is located above the periosteal layer. Clinically, it may be associated with mild bruising of the overlying skin, but it is generally self-limiting and does not require specific treatment. Resolution typically occurs spontaneously within the first few days of life. Although rare, complications such as skin breakdown over the affected area may occur, potentially leading to necrosis, scarring, or localized alopecia. In extremely uncommon cases, secondary infection may develop, requiring medical intervention. Skull fractures represent a more serious form of neonatal cranial injury and are most commonly associated with instrument-assisted deliveries, particularly those involving forceps or vacuum extraction. These fractures may be linear or depressed, with the latter carrying a higher risk of underlying brain injury. In many cases, skull fractures remain clinically silent and are discovered incidentally during evaluation for other conditions. However, when neurological signs are present, such as seizures, altered consciousness, or focal neurological deficits, the possibility of intracranial injury must be considered. Initial diagnosis is often confirmed using plain radiographic imaging of the skull, although this modality has limited sensitivity for intracranial pathology. When clinical suspicion of brain injury exists, advanced imaging techniques such as computed tomography or magnetic resonance imaging are indicated to assess the extent of injury and guide management decisions. The clinical approach to neonatal physical birth trauma requires early recognition, careful monitoring, and appropriate escalation of care when necessary. While many injuries such as caput succedaneum are benign and self-limiting, others, particularly skull fractures with potential intracranial involvement, require urgent evaluation and multidisciplinary management. Prognosis varies widely, ranging from complete spontaneous recovery in mild cases to long-term neurological impairment in severe injuries, emphasizing the importance of timely diagnosis and individualized clinical management.

Extracranial Hemorrhages

Cephalohematoma

Cephalohematoma is a neonatal extracranial hemorrhage characterized by a localized collection of blood beneath the periosteum of the skull. It develops when small blood vessels traversing from the skull bone to the periosteal layer rupture during the mechanical stress of childbirth. The periosteum is firmly adherent to the skull at suture lines, which results in a well-demarcated swelling that does not cross these sutures. This anatomical restriction is a key diagnostic feature that differentiates cephalohematoma from other forms of scalp swelling. The condition most frequently presents as a unilateral lesion and may become more apparent several hours after birth as bleeding slowly accumulates. Cephalohematoma is more commonly associated with instrumental deliveries, particularly those involving vacuum extraction or forceps application, due to increased mechanical pressure and localized trauma to the fetal skull. Epidemiological data suggest an incidence of up to 2.5% of all live births, with higher rates observed in assisted vaginal deliveries [21]. In most cases, the condition is benign and self-limiting. Spontaneous resolution typically occurs within a period ranging from two weeks to three months without the need for specific medical intervention.

During this resolution phase, gradual reabsorption of the hematoma occurs as hemoglobin breakdown products are metabolized. Although the prognosis is generally favorable, cephalohematoma may be associated with several complications. One of the most commonly observed is hyperbilirubinemia, resulting from the breakdown of accumulated red blood cells within the hematoma. Less frequently, calcification of the hematoma may occur, leading to palpable bony irregularities or cosmetic skull deformities. In rare cases, secondary infection may develop, which can progress to osteomyelitis if not promptly recognized and managed. Careful clinical observation is therefore essential to distinguish uncomplicated cases from those requiring further intervention.

Subgaleal Hemorrhage

Subgaleal hemorrhage represents a more severe and potentially life-threatening form of extracranial bleeding. It occurs in the potential space between the galea aponeurotica and the periosteum of the skull, an area composed of loose areolar connective tissue that allows for extensive blood accumulation. The primary mechanism of injury involves traction forces that separate the scalp from the underlying calvarium, resulting in rupture of emissary veins and bridging vessels. This condition is most commonly associated with vacuum-assisted or forceps-assisted vaginal deliveries, where excessive mechanical force is applied to the fetal head. The incidence of subgaleal hemorrhage is relatively low in spontaneous vaginal deliveries, estimated at approximately 4 per 10,000 births, but increases significantly to around 59 per 10,000 in vacuum-assisted deliveries [22]. Despite its rarity, it carries a high risk of morbidity and mortality due to the large potential space available for blood accumulation beneath the scalp. This anatomical feature allows significant blood loss to occur without immediate external signs, which can rapidly lead to hypovolemic shock, coagulopathy, multiorgan failure, and death if not recognized early. Clinical presentation may include diffuse, fluctuant scalp swelling that crosses suture lines, pallor, tachycardia, hypotension, and a declining hematocrit. The condition requires urgent recognition and intensive supportive management. Treatment focuses on stabilization of the neonate, including airway management, circulatory support, and prompt blood product transfusion, such as packed red blood cells or fresh frozen plasma, to restore intravascular volume and correct coagulopathy. Unlike localized hematomas, the accumulated blood in the subgaleal space is not surgically drained; instead, it is gradually reabsorbed as the patient stabilizes. Early identification and aggressive supportive care are critical determinants of outcome in affected neonates.

Intracranial Hemorrhages and Brachial Plexus Injuries

Intracranial hemorrhages in the neonatal period represent a serious category of traumatic birth injuries with significant implications for neurological outcomes and survival. These hemorrhages are primarily classified into epidural, subdural, subarachnoid, and intraventricular types, each with distinct pathophysiological mechanisms, clinical presentations, imaging characteristics, and management strategies. Although relatively uncommon compared to extracranial injuries, intracranial hemorrhages require urgent recognition due to their potential for rapid neurological deterioration and long-term neurodevelopmental impairment. Epidural hemorrhage in neonates is rare but clinically significant when it occurs. It is most commonly associated with linear skull fractures in the parietotemporal region, particularly following operative vaginal deliveries that involve mechanical force applied to the fetal head. The pathophysiology involves rupture of arterial vessels between the skull and dura mater, leading to accumulation of blood in the epidural space. Clinical presentation may include bulging of the anterior fontanelle, irritability, altered level of consciousness, hypotonia, bradycardia, hypotension, and seizure activity. These signs reflect increasing intracranial pressure and potential brain compression. Diagnostic confirmation is achieved through neuroimaging, typically computed tomography or magnetic resonance imaging, which demonstrates a lens-shaped or convex hyperdense collection characteristic of epidural bleeding. Given the risk of rapid expansion and neurological compromise, prompt neurosurgical intervention is often required to evacuate the hematoma and relieve intracranial pressure.

Subdural hemorrhage is the most frequently encountered form of intracranial bleeding in neonates and is strongly associated with mechanical stress during delivery, particularly operative vaginal birth. It typically results from rupture of bridging veins between the cerebral cortex and dural sinuses. The hemorrhage most commonly localizes over the cerebral convexities due to shearing forces applied during passage through the birth canal. Clinical manifestations vary depending on severity and may include bulging fontanelle, irritability, altered consciousness, respiratory depression, apnea, bradycardia, abnormal muscle tone, and seizures. In some cases, subdural hemorrhage may be detected incidentally in asymptomatic neonates during imaging performed for unrelated reasons, indicating a spectrum of clinical severity. Management is determined by the extent of hemorrhage and the presence of raised intracranial pressure. Conservative observation is appropriate in mild or asymptomatic cases, whereas surgical evacuation may be indicated in extensive hemorrhages associated with neurological compromise or progressive clinical deterioration. Subarachnoid hemorrhage is the second most common type of neonatal intracranial hemorrhage and arises from rupture of small bridging vessels within the subarachnoid space. Similar to other forms of traumatic intracranial bleeding, operative vaginal delivery is a recognized risk factor. Most affected neonates remain asymptomatic when the hemorrhage is limited in extent, reflecting the capacity of the subarachnoid space to accommodate small volumes of blood without significant mass effect. However, more extensive hemorrhage may present with seizures, apnea, or

signs of increased intracranial pressure. Rare etiologies include ruptured vascular malformations, although these are uncommon in the neonatal population. Treatment is generally conservative, focusing on supportive care and monitoring for neurological complications, as most cases resolve spontaneously without surgical intervention.

Intraventricular hemorrhage primarily affects premature infants due to the fragility of the germinal matrix vasculature, although it may also occur in term neonates depending on the severity of birth trauma. The condition involves bleeding into the ventricular system of the brain and may extend into surrounding brain parenchyma in severe cases. Clinical outcomes are closely linked to the grade of hemorrhage, with higher grades associated with increased risk of hydrocephalus, neurodevelopmental delay, and cerebral palsy. Early detection through cranial ultrasound or advanced neuroimaging is essential for appropriate management and prognostication [23]. Brachial plexus injuries represent an important category of peripheral nerve trauma associated with birth-related mechanical forces. These injuries occur in approximately 2.5 per 1000 live births and result from excessive traction on the cervical nerve roots during delivery. The condition is typically unilateral and is strongly associated with risk factors such as fetal macrosomia, shoulder dystocia, prolonged or difficult fetal extraction, breech presentation, multiparity, and operative vaginal deliveries [24]. The severity and pattern of neurological deficit depend on the specific nerve roots involved, leading to distinct clinical syndromes.

Erb-Duchenne palsy is the most common form of brachial plexus injury and results from injury to the fifth and sixth cervical nerve roots. This leads to weakness of the upper arm muscles, with the characteristic “waiter’s tip” posture, which includes adduction and internal rotation of the arm, extension at the elbow, and flexion of the wrist and fingers. This pattern reflects disruption of shoulder abduction and external rotation mechanisms while preserving distal hand function. Klumpke palsy results from injury to the eighth cervical and first thoracic nerve roots and is less common. It primarily affects the intrinsic muscles of the hand, leading to paralysis of hand movements, absent grasp reflex, and sensory deficits along the ulnar aspect of the forearm and hand. In more severe cases, associated involvement of the sympathetic chain may produce additional autonomic symptoms. Total brachial plexus injury occurs when all involved nerve roots are affected, resulting in complete paralysis of the upper limb. This represents the most severe form of plexus injury and is associated with significant functional impairment if recovery is incomplete. Phrenic nerve involvement may occur in association with brachial plexus injury, particularly in extensive traction injuries affecting the cervical roots. Clinical manifestations include tachypnea, asymmetric chest movement, and decreased breath sounds on the affected side, reflecting diaphragmatic paralysis. This condition may further compromise respiratory function in the immediate neonatal period. The majority of brachial plexus injuries are stretch-related and demonstrate favorable recovery with conservative management. Initial treatment focuses on observation and structured physical therapy to maintain joint mobility and prevent contractures. Occupational therapy plays a key role in functional rehabilitation and motor skill development. Approximately 70% to 80% of affected infants achieve complete recovery, particularly when early neurological improvement is observed. However, lack of full recovery by three months of age is strongly associated with persistent functional impairment, most commonly affecting shoulder abduction, elbow flexion, or forearm supination. Early referral to specialized brachial plexus injury centers is essential to optimize outcomes, allowing for multidisciplinary management that may include physical rehabilitation, occupational therapy, and surgical nerve reconstruction in selected cases.

Birth Trauma Preventative Strategies

Prevention of birth trauma depends on structured, multidisciplinary systems that integrate antenatal planning, intrapartum coordination, and postpartum surveillance. The core principle is anticipation of risk rather than reaction to complications. This requires collaboration between obstetricians, midwives, neonatologists, pediatricians, nurses, social workers, mental health professionals, and allied health services. Each discipline contributes specific expertise that collectively reduces preventable maternal and neonatal injury. Emergency specialists play a central role in high-risk deliveries and unexpected obstetric complications. Their primary function is rapid stabilization when acute deterioration occurs in either the mother or the newborn. In cases such as shoulder dystocia, neonatal resuscitation, severe postpartum hemorrhage, or suspected intracranial injury, emergency physicians provide immediate airway, breathing, and circulatory support. They also coordinate escalation pathways, ensuring timely transfer to intensive care or surgical intervention when required. Their training in acute resuscitation and trauma management allows them to bridge obstetric and neonatal emergencies, particularly when complications occur outside tertiary maternity centers or when rapid deterioration exceeds obstetric team capacity.

Paramedics contribute significantly in prehospital and transfer settings. Their role begins with early recognition of obstetric risk during emergency transport, including preterm labor, maternal trauma, or fetal distress. They ensure safe maternal positioning, initiate basic neonatal resuscitation when delivery occurs outside hospital settings, and provide stabilization during interfacility transfers to specialized obstetric or neonatal units. Paramedics also support communication between referring facilities and receiving hospitals, ensuring that critical clinical information such as gestational age, labor progression, and maternal risk factors is relayed accurately. Their ability to deliver time-sensitive interventions in uncontrolled environments is essential in reducing delays that can worsen outcomes in both maternal and neonatal populations. Epidemiologists contribute at the population level by identifying patterns, risk factors, and outcomes associated with birth trauma. Their work involves analyzing large datasets to detect trends in maternal and

neonatal injury, evaluating the effectiveness of preventive interventions, and identifying disparities in care. Epidemiological surveillance helps determine how factors such as maternal age, socioeconomic status, obstetric practices, and access to prenatal care influence trauma incidence. These insights inform public health policy, guide clinical guideline development, and support resource allocation to high-risk populations. Epidemiologists also play a key role in monitoring long-term outcomes of birth trauma, including neurodevelopmental impairment and maternal mental health sequelae, thereby contributing to continuous quality improvement in maternity care systems.

Nursing professionals occupy a continuous and central role across antenatal, intrapartum, and postpartum care. During labor, nurses provide direct bedside monitoring of maternal vital signs, fetal heart rate patterns, and labor progression. They are often the first to detect early signs of distress or deviation from normal labor patterns. Their role includes implementing obstetric protocols, assisting with operative vaginal deliveries, supporting pain management strategies, and ensuring adherence to safety checklists during high-risk births. Nursing staff also play a key role in patient communication, providing reassurance, education, and emotional support to reduce anxiety and improve patient experience. In the postpartum period, nurses are responsible for early detection of both maternal and neonatal complications. This includes assessment for perineal trauma, hemorrhage, infection, and psychological distress such as postpartum depression or acute stress reactions. They also monitor newborns for signs of birth injury, feeding difficulties, and neurological abnormalities. Nursing staff facilitate early bonding, breastfeeding support, and parental education regarding warning signs that require urgent medical attention. Their continuous presence makes them essential in bridging communication between multidisciplinary teams. Preventive strategies are strengthened through coordinated antenatal risk assessment. Early identification of fetal macrosomia, malpresentation, maternal comorbidities, or psychological vulnerability allows teams to plan delivery in appropriate clinical settings. Shared decision-making and structured communication tools ensure that all team members are aware of potential complications before labor begins. Simulation training for obstetric emergencies, including shoulder dystocia and neonatal resuscitation, improves team readiness and reduces response times during critical events.

Postpartum follow-up is equally important in prevention frameworks. Infants exposed to birth trauma require ongoing assessment for neurodevelopmental delay, motor impairment, or sensory dysfunction. Early referral to physiotherapy, occupational therapy, and speech therapy improves long-term outcomes and reduces disability burden. Maternal follow-up includes screening for psychological sequelae such as anxiety, depression, and posttraumatic stress disorder, with timely referral to mental health services when needed. Overall, effective prevention of birth trauma depends on synchronized action across multiple disciplines. Emergency specialists provide rapid response during crises, paramedics ensure safe prehospital stabilization, epidemiologists guide system-level prevention through data analysis, and nursing staff maintain continuous surveillance and patient-centered care. When these roles are integrated within a structured healthcare system, the incidence and severity of birth trauma can be significantly reduced while improving both maternal and neonatal outcomes.

Conclusion

Birth trauma represents a complex clinical and psychosocial condition affecting both mothers and neonates across physical and psychological domains. Physical injuries include perineal trauma, intracranial hemorrhages, extracranial bleeding, and nerve injuries, while psychological consequences include postpartum depression, anxiety, and posttraumatic stress disorder. Risk factors span fetal, maternal, procedural, antenatal, intrapartum, and postnatal domains, making prevention dependent on early identification and multidisciplinary coordination. Neonatal outcomes vary from self-limiting conditions such as caput succedaneum to life-threatening complications like subgaleal hemorrhage and intracranial bleeding, requiring rapid recognition and intervention. Maternal outcomes extend beyond immediate injury to long-term pelvic floor dysfunction and psychological morbidity. Effective management depends on integrated care involving emergency physicians, paramedics, nurses, epidemiologists, obstetric teams, and mental health professionals. Strengthening antenatal screening, improving intrapartum response systems, and ensuring structured postpartum follow-up reduces morbidity and mortality. Continued emphasis on trauma-informed care, early diagnosis, and interprofessional collaboration remains essential to improving maternal and neonatal health outcomes and reducing the global burden of birth-related injuries.

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