# Hormonal Physiology of Childbearing: Fact Sheets on Core Topics for Maternity Care Providers

A new report, ***Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care*** (2015), synthesizes an extensive literature about hormonally-driven processes of parturition and the early postpartum period. The information sheets provided here are drawn from this report.

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Contemporary childbirth has benefited greatly from medical advances and from highly skilled and committed maternity care providers. However, the current technology-intensive approach may be disadvantageous for healthy mothers and babies. Current understanding of physiologic processes around the time of birth suggests that these processes and practices that help foster them confer important benefits to women and their fetuses/newborns. Common interventions can interfere with these benefits and are best reserved for well-established indications.

**These fact sheets cover the following topics:**




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# 1. The Hormonal Cascade of Childbearing

A new report, ***Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care*** (2015), synthesizes an extensive literature about hormonally-driven processes of parturition and the early postpartum period. The following information is drawn from this report.

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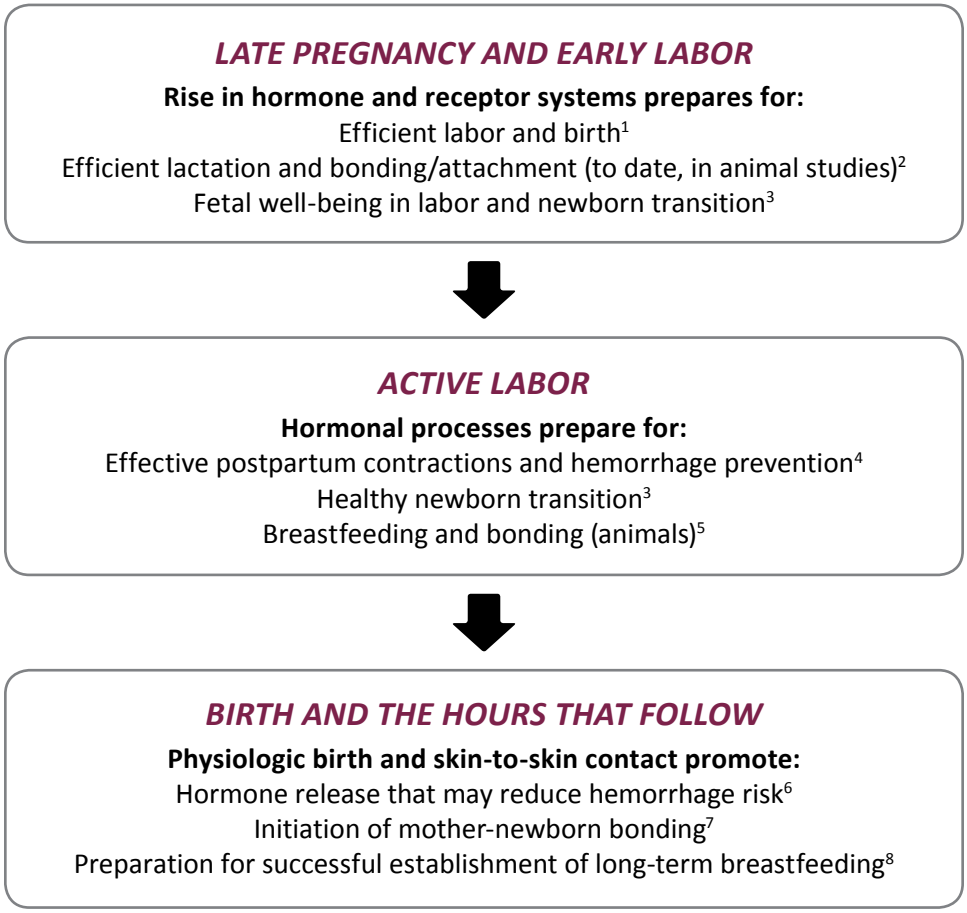
Hormonal physiology of childbearing involves complex interconnected beneficial processes. Hormonal actions of one phase anticipate and prepare for subsequent phases. In healthy pregnancies, these processes foster efficient labor, safety for mother and infant, successful breastfeeding, and optimal mother-newborn bonding. The following graphic highlights key actions at each phase.

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Access *Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care* (2015) by Dr. Sarah J. Buckley and related material, including individual fact sheets and the full set, at ChildbirthConnection.org/HormonalPhysiology.

## Selected references – see report for additional documentation:


1. Fuchs, A.R., et al. (1984). Oxytocin receptors in the human uterus during pregnancy and parturition. *Am J Obstet Gynecol, 150*(6), 734-741.
2. Russell, J.A., et al. (2001). Brain preparations for maternity—adaptive changes in behavioral and neuroendocrine systems during pregnancy and lactation. An overview. *Prog Brain Res, 133*, 1-38.
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# 2. Core Hormonal Physiology of Childbearing Principles

A new report, ***Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care*** (2015), synthesizes an extensive literature about hormonally-driven processes of parturition and the early postpartum period. The following information is drawn from this report.

**The scientific literature on the hormonal physiology of childbearing reveals core themes and principles. These themes and principles reflect profound interconnections at many levels and over time, as follows:**

**Evolutionary origins.** The hormonal physiology of childbearing has evolved over millions of years to optimize reproductive success. Maternal and infant survival at birth is obviously critical for reproductive success, but equally important for long-term survival are successful lactation and maternal-infant attachment immediately following birth.[1] These hormonally-mediated processes are intertwined and continuous with the biologic processes of parturition. Disruption of perinatal hormonal physiology may thus adversely impact not only labor and birth, but also breastfeeding and maternal-infant attachment via biological bonding.[2] As humans share many reproductive processes with other mammals, animal research helps illuminate human hormonal physiology, especially where human research is currently limited.[1]

**Mother-baby dyad.** Hormonal physiology is interrelated, coordinated, and mutually regulated between mother and baby to optimize outcomes for both. For example, maternal and fetal readiness for labor is precisely aligned at the physiologic onset of term labor to optimize labor efficiency and maternal and newborn transitions. Similarly, skin-to-skin contact after birth mutually regulates maternal and newborn oxytocin systems.[3] As a general principle, effects on maternal hormonal physiology impact fetal/newborn hormonal physiology, and vice versa.

**Beneficial hormonal physiology pathway.** From pregnancy through labor and birth, breastfeeding, and maternal-infant attachment, hormonal processes of physiologic childbearing anticipate and prepare for upcoming processes and biological needs. For example, prelabor upregulation of maternal uterine oxytocin receptors promotes labor efficiency,[4] and prelabor epinephrine-norepinephrine receptor upregulation optimizes fetal adaptations to labor hypoxia and newborn transitions via the fetal catecholamine surge.[5]

**Interorchestration among hormone systems.** The hormone systems described in the *Hormonal Physiology of Childbearing* report – oxytocin, beta-endorphins, epinephrine-norepinephrine and related stress systems, and prolactin – have complex interactions in the perinatal period, including promoting or inhibiting one another's activity.[6] This can amplify hormonal effects, leading to the peaks that characterize physiologic birth. For example, late-labor oxytocin peaks, promoted by high levels of prolactin and oxytocin itself, assist with the pushing stage.[7] Similarly, excessive stress and stress hormones may disrupt labor progress via hormonal interorchestration.[8]

**Cascade of intervention.** Hormonal disruptions can be amplified when one intervention necessitates and leads to another that is used to monitor, prevent, or treat its side effects. This escalation of technology can further disrupt hormonal physiology and introduce extra risks to mother and baby. For example, the reduction in maternal oxytocin that generally follows administration of epidural analgesia[9] may lead to use of synthetic oxytocin to compensate. Prolonged use of synthetic oxytocin may desensitize the oxytocin receptor system[10] and increase the risk of postpartum hemorrhage.

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**Concern about long-term impacts.** Non-physiologic exposures during the sensitive perinatal period may disrupt offspring hormone systems, with amplified and/or enduring biological, developmental, and/or behavioral impacts,[11] as found in animal offspring, [12] likely via epigenetic programming effects. High-quality, long-term human studies following fetal/newborn exposure to perinatal drugs and interventions are very limited.[13] Thus, the current evidence-based approach to identifying safe and effective care, based on short-term follow-up and limited examination of hormonally-mediated outcomes such as breastfeeding, may not adequately safeguard mothers and babies. Similarly, conventional shorter-term pharmacologic considerations of fetal/newborn drug exposure (e.g., dose, duration, metabolism) may not adequately safeguard the baby. Current levels of uncertainty about long-term impacts suggest research priorities[14] and support avoiding unneeded interventions.

## Selected references – see report for additional documentation:


1. Naaktgeboren, C. (1989). The biology of childbirth. In I. Chalmers, M. Enkin & M. N. Keirse (Eds.), *Effective care in pregnancy and childbirth* (Vol. 2, pp. 795-804). Oxford: Oxford University Press.
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# 3. Physiologic (Spontaneous) Onset of Labor versus Scheduled Birth

A new report, ***Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care*** (2015), synthesizes an extensive literature about hormonally-driven processes of parturition and the early postpartum period. The following information is drawn from this report.

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Many women and babies experience scheduled birth – induced labor and/or prelabor cesarean – annually in the United States.[1] This fact sheet highlights key benefits of the spontaneous, physiologic onset of labor at term, including fully experiencing beneficial hormonal actions of late pregnancy and early labor, and identifies practices that support hormonal physiology when scheduled birth is medically necessary.

## Benefits of hormonal preparations of late pregnancy and of physiologic onset of labor

Hormonal processes that lead up to the physiologic onset of labor prepare mother and fetus/newborn for upcoming tasks and phases. For example:

- Increases in oxytocin[2] and prostaglandin[3] receptors, at the physiologic onset of labor prime the uterus to promote effective contractions in labor.
- Increases in brain-based (central) receptors for beta-endorphins prepare endogenous pain-relieving pathways (to date, found in animal studies).[4]
- Elevations in mammary and central oxytocin and prolactin receptors prepare for breastfeeding and maternal-infant biological bonding.[5]
- Rising cortisol supports maturation of the fetal lungs and other organs. Prelabor preparations in oxytocin and catecholamine systems promote fetal protective processes in labor and optimal newborn transition.[6]

## Practices that support beneficial hormonal action when scheduled birth is necessary

When scheduled birth and other interventions are medically necessary, childbearing women and newborns can benefit from support of physiologic processes as far as safely possible. Ways to foster these processes include:

- Induce labor or schedule cesarean as close as is safely possible to the physiologic onset of labor.
- Begin with least invasive/lowest dose interventions to minimize hormonal disruption.
- Maintain a calm, low-stress environment in labor, as high levels of stress may interfere with labor progress via several hormone pathways.[7]
- Promote skin-to-skin contact between mother and baby immediately after birth to optimize maternal and newborn oxytocin levels,[8] support breastfeeding success,[9] enhance maternal-infant bonding behavior,[10] and likely reduce postpartum hemorrhage risks.

**Precautionary Point:** Developmental and epigenetic principles suggest that perinatal manipulations and exposures could have long-lasting programming effects.[11] Animal research finds effects on offspring hormonal systems through to adulthood from newborn synthetic oxytocin administration.[12, 13] While this research is still developing, a precautionary approach to exposures in essentially healthy women and babies is prudent.

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## Selected references – see report for additional documentation:


1. Centers for Disease Control and Prevention. User guide to the 2012 natality public use file.
2. Fuchs, A.R., et al. (1984). Oxytocin receptors in the human uterus during pregnancy and parturition. *Am J Obstet Gynecol, 150*(6), 734-741.
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# 4. Low-Stress Birthing Environments

A new report, ***Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care*** (2015), synthesizes an extensive literature about hormonally-driven processes of parturition and the early postpartum period. The following information is drawn from this report.

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Stress at healthy levels ("eustress") and its hormonal effects can benefit women and babies around the time of birth. However, women may experience maternity care facilities as excessively stressful in labor, birth and the postpartum period.[1] Unknown or harried personnel, noise, unfamiliar or unsupportive language, lack of privacy, and separation from their newborn can contribute. This fact sheet summarizes the beneficial hormone actions of eustress, the benefits of lowering stress in the birthing environment through the lens of hormonal physiology, and practices that support beneficial hormonal physiology in conditions of stress.

## Stress hormones during labor and birth:

- Short-term elevations in epinephrine, norepinephrine and cortisol occur in response to labor stress and pain.[2] In the right amount ("eustress"), the mother remains alert and focused.
- Short-term fetal elevations in epinephrine and norepinephrine also occur in labor. A surge of these catecholamine hormones in late labor protects the fetus from hypoxia and promotes neonatal transitions, including optimizing breathing, temperature, and glucose regulation. These hormones also promote newborn alertness, benefitting bonding and breastfeeding initiation.[3]
- In conditions of excessive maternal stress, elevation of epinephrine and norepinephrine may cause blood flow to be diverted away from the uterus and baby[4] and toward the heart, lungs and muscles as part of the "fight or flight" response. Catecholamine elevation may also stall labor[5] as an evolutionary mechanism to support flight or flight in the presence of danger. These stress responses may explain the common phenomena of slowing labor on admission to the hospital.[6]
- Other possible stress pathways that slow labor may include: elevations in beta-endorphins, which reduce central oxytocin; reduction in oxytocin by catecholamines; and inhibiting effects of stress on pulsatile oxytocin release.[7]
- Following birth, maternal and newborn stress and stress hormone levels drop quickly. Stress reduction is supported by elevations in calming and rewarding hormones, including oxytocin and beta-endorphins, promoted by maternal-newborn skin-to-skin contact.[8, 9]

## Benefits of low-stress birthing environments:

- Creating a calm, relaxed, and emotionally supportive atmosphere for labor and birth may benefit labor progress by reducing excessive stress and catecholamines.
- Lower levels of stress, for example through labor support,[10] may help women cope well with labor pain, decrease the need for pharmacologic pain management, and reduce the hormonal interruptions of epidural analgesia.
- Lower levels of stress may promote uterine blood supply, improving fetal and newborn well-being,[5] especially of vulnerable babies.
- Low levels of stress after birth, facilitated by uninterrupted mother-newborn contact, may promote breastfeeding and maternal-infant attachment, including by elevating oxytocin levels.[8] Postpartum hemorrhage risks may be lowered.

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## Practices that support beneficial hormonal action, especially when unpreventable stress occurs and/or hormonal physiology is disrupted

In excessively stressful situations, childbearing women and newborns can benefit from support of physiologic processes as far as safely possible. Ways to foster these processes include:

- Provide labor support, such as doula care, to laboring women to reduce stress and its impacts.[10]
- Ensure early and uninterrupted maternal-newborn skin-to-skin contact. This may reduce stress hormones for both, and benefit newborn transition[9] and breastfeeding initiation.[11] Oxytocin elevations[11] and stress hormone reductions may also reduce the risk of postpartum hemorrhage.
- Support the early initiation of breastfeeding, which also promotes the release of calming, rewarding hormones for mother and baby.

**Precautionary Point:** Both animal[12] and provisional human[5] research suggest adverse effects of labor stress. Possible impacts include prolonged labor and fetal hypoxia, with increased morbidity and mortality in animal studies.[12, 13] Slow labor and suspected fetal hypoxia are common reasons for labor interventions. Reducing stress in laboring women, as suggested above, may be a simple low-technology approach with substantial benefits, including reduced need for interventions**.**

## Selected references – see report for additional documentation:


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# 5. Non-Pharmacologic Pain Management versus Epidural Analgesia

A new report, ***Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care*** (2015), synthesizes an extensive literature about hormonally-driven processes of parturition and the early postpartum period. The following information is drawn from this report.

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Birth certificates report that epidural or spinal analgesia is used in about 72% of labors in the United States.[1] This fact sheet summarizes the beneficial hormone actions of physiologic childbearing (conforming to healthy biologic processes), the hormonal benefits of non-pharmacologic pain management, and practices that support beneficial hormonal physiology when epidural analgesia is administered.

## Beneficial hormonal actions during labor:

- Endogenous oxytocin levels increase throughout labor,[2] contributing to effective labor progress and endogenous analgesia. Oxytocin peaks in the pushing stage promote efficient expulsion. In the hour after birth, further oxytocin peaks[3] promote uterine contractions and may reduce hemorrhage risk. Physiologic oxytocin activity may also support successful breastfeeding.
- Prolactin hormone actions are synergistic with oxytocin and also peak in the hour after birth, supporting early lactation.[4]
- Endogenous beta-endorphins rise with increasing levels of labor pain,[5] giving endogenous analgesia and may activate reward systems after birth in relation to birth and baby.[6]
- Maternal epinephrine and norepinephrine (catecholamines) increase in response to labor pain.[7] When the mother's pain and fear levels remain in tolerable states of "eustress," catecholamines promote alertness and effective pushing. When stress is excessive, labor may slow via elevations in catecholamines and several other hormonal pathways.

## Benefits of non-pharmacologic pain management:

- Non-pharmacologic pain management (for example, immersion in water, relaxation techniques, labor support, and massage) avoids the risks of epidural analgesia, which can interrupt endogenous oxytocin,[8] beta-endorphins,[9] epinephrine-norpeinephrine,[7]and prolactin,[10] and their physiologic peaks in late labor. Oxytocin reduction may increase the need for synthetic oxytocin, and for vacuum or forceps assisted birth.[11] Although not well studied, epidural analgesia may adversely impact breastfeeding success.
- Labor support by a trained doula provides emotional support and physical comfort.[12] Reductions in stress and catecholamines may mediate benefits of doula care and may also optimize oxytocin, prolactin, and beta-endorphins. Lower epidural rates and increased vaginal birth and breastfeeding rates of women with doula care[12] may reflect hormonal benefits from reduced stress.

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## Practices that support beneficial hormone action when epidural analgesia is needed

When epidural and other interventions are used, childbearing women and newborns can benefit from support of physiologic processes as far as safely possible. Ways to foster these processes include:

- Provide non-pharmacologic options ("comfort measures") in early labor to promote coping and delay epidural administration. Delayed epidural administration may reduce hormonal effects, as seen in animal studies.[13]
- Promote skin-to-skin contact in the first hours after birth. This may benefit maternal oxytocin, beta-endorphins, and prolactin, and counter any adverse effects on breastfeeding.[14] This may also benefit newborn transition[19] and breastfeeding initiation[15] and reduce postpartum hemorrhage risk by elevating maternal oxytocin.[3]

**Precautionary Point:** Long-term studies of possible effects from fetal exposure to analgesic drugs in labor are lacking. Developmental and epigenetic principles suggest that perinatal exposures could have long-lasting programming effects.[16] Limited animal[17] and human studies[18] suggest cause for concern. While this research is sparse, a precautionary approach to exposures in essentially healthy women and babies is prudent, while we await more definitive data.

## Selected references – see report for additional documentation:


1. Centers for Disease Control and Prevention. User guide to the 2012 natality public use file.
2. Fuchs, A.R., et al. (1991). Oxytocin secretion and human parturition: Pulse frequency and duration increase during spontaneous labor in women. *Am J Obstet Gynecol, 165*(5 Pt 1), 1515-1523.
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**16.** Dahlen, H.G., et al. (2013). The EPIIC hypothesis: Intrapartum effects on the neonatal epigenome and consequent health outcomes. *Med Hypotheses, 80*(5), 656-662.
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www.NationalPartnership.org
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# 6. Physiologic Birth versus Cesarean Section

A new report, ***Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care*** (2015), synthesizes an extensive literature about hormonally-driven processes of parturition and the early postpartum period. The following information is drawn from this report.

One in three babies is born by cesarean birth in the United States today.[1] The following information summarizes the beneficial hormone actions of childbearing that is physiologic (conforming to healthy biologic processes), the likely clinical benefits of physiologic birth through the lens of hormonal physiology, and practices that may safely benefit hormonal physiology when a cesarean is necessary.

## Hormonal actions of physiologic birth:

- Central oxytocin elevations in labor[2] counteract stress and pain[3] and promote maternal adaptations and attachment.[4] Postpartum oxytocin peaks[5] may reduce hemorrhage risk.
- The fetal catecholamine surge of late labor prepares for newborn respiratory transition, thermoregulation, and glucose regulation.[6]
- Maternal and fetal "eustress" of labor promotes alertness, bonding, and breastfeeding initiation after birth.[6, 7]
- Uninterrupted skin-to-skin contact promotes further activation of maternal and newborn oxytocin systems, enhancing breastfeeding and bonding.[7]
- Prolactin hormonal activation following physiologic birth supports breastfeeding and attachment physiology.[8]

## Benefits of physiologic versus cesarean birth through the lens of hormonal physiology:

- lower rates of newborn respiratory stress and intensive care admissions[9]
- higher rates of breastfeeding[10]
- maternal brain adaptations that promote responsiveness to infants[11]
- less separation of mother and baby,[12] contributing to breastfeeding and biologic bonding

## Practices that support beneficial hormonal action when cesarean is necessary

When cesarean birth and other interventions are medically necessary, childbearing women and newborns can benefit from support of physiologic processes as far as safely possible. Ways to foster these processes include:

- Schedule cesarean as close as safely possible to the onset of physiologic labor to benefit maternal and fetal readiness.
- Post-cesarean, support early and uninterrupted skin-to-skin mother-baby contact, ideally beginning as soon as possible in the operating or recovery room. In the absence of complications, mother and baby should be together within an hour of birth.[13] Early contact may elevate maternal and newborn oxytocin levels,[5] reducing stress, and possibly decreasing hemorrhage risks.
- Early breastfeeding initiation also promotes release of oxytocin and prolactin, promoting successful breastfeeding over the longer term[14]

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Access *Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care* (2015) by Dr. Sarah J. Buckley and related material, including individual fact sheets and the full set, at ChildbirthConnection.org/HormonalPhysiology.

**Precautionary Point:** Accumulating evidence shows negative impacts in cesarean-born offspring, including short-term respiratory morbidities and longer-term immune and metabolic dysfunctions,[15] Lack of the physiologic trajectories of vaginal birth has been implicated.[15]

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# 7. Early Skin-to-Skin Contact Between Mothers and Newborns

A new report, ***Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care*** (2015), synthesizes an extensive literature about hormonally-driven processes of parturition and the early postpartum period. The following information is drawn from this report.

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Separation of mothers and babies after birth is common practice in many facilities,[1] particularly in relation to cesarean, episiotomy or laceration repair, or newborn examination and routine care. This fact sheet summarizes the beneficial hormone actions of mother-newborn skin-to-skin contact (SSC), the benefits of SSC through the lens of hormonal physiology, and practices that support beneficial hormonal physiology when separation of mother and infant is necessary.

## Hormonal action just after birth

In the minutes to hours after labor and birth that started and progressed physiologically, through healthy biologic processes and without effects of medications, procedures, and/or mother-baby separation:

- Early maternal oxytocin peaks in relation to maternal-infant SSC and interactions[2] may help prevent postpartum hemorrhage and promote biologic bonding and maternal adaptations.[3] The first hour may be a period of exceptional sensitivity for mother and baby.
- Maternal prolactin peaks in the first hour after birth[4] may facilitate breastfeeding.
- Fetal oxytocin elevations with SSC in the first hours after birth [2] may promote a calm and alert state that facilitates breastfeeding initiation.[3, 5]

## Benefits of skin-to-skin contact through the lens of hormonal physiology:

- Uninterrupted SSC and breastfeeding initiation may promote further rises in maternal oxytocin[2] and prolactin systems, promoting breastfeeding and bonding, and possibly preventing postpartum hemorrhage.
- SSC promotes maternal vasodilation,[6] warming the infant and preventing hypothermia.
- SSC reduces newborn stress and stress hormones, optimizing newborn transitional physiology, including energy consumption, glucose levels, respiration, crying and breastfeeding behaviors.
- SSC promotes breastfeeding through early lactation hormone action, increasing the chances of exclusive and longer-term breastfeeding.[7]
- Following epidural anesthesia or cesarean birth—which may adversely impact the physiologic peaks of oxytocin,[8] beta-endorphins[9] and/or prolactin[10] of mother and newborn—SSC may compensate to some extent, with possible benefits to breastfeeding,[11] bonding, hemorrhage risk, and/or newborn transition.
- Ongoing skin-to-skin contact during the early days and weeks may have benefits to maternal mental health,[12] likely via peaks of oxytocin and prolactin, both stress reducing.

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Access *Hormonal Physiology of Childbearing: Evidence and Implications for Women, Babies, and Maternity Care* (2015) by Dr. Sarah J. Buckley and related material, including individual fact sheets and the full set, at ChildbirthConnection.org/HormonalPhysiology.

## Practices that support beneficial hormone action when separation is necessary

When separation of mother and baby is medically necessary, childbearing women and newborns can benefit from support of physiologic processes as far as safely possible. Ways to foster these processes include:

- Skin-to-skin contact may be beneficial for mother and baby even after the sensitive hour or so after birth, including for breastfeeding initiation.
- Breastfeeding, like SSC, releases oxytocin, prolactin and beta-endorphins, all soothing and rewarding hormones for mother and baby. Breastfeeding can optimize hormonal physiology and/or reduce stress for mother and baby at any time.

**Precautionary Point:** Animal studies show long-term disruptions to hormonal systems and functioning following brief daily maternal-newborn separation, which is used as an animal model for depression[13] and addiction.[14] Human studies also suggest significant stress for separated newborns.[15]

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