Neonatal Golden Hour: a review of current best practices and available evidence

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Purpose of review
Recommendations made by several scientific bodies advocate for adoption of evidence-based interventions during the first 60 min of postnatal life, also known as the Golden Hour, to better support the fetal-to-neonatal transition. Implementation of a Golden Hour protocol leads to improved short-term and long-term outcomes, especially in extremely premature and extreme low-birth-weight (ELBW) neonates. Unfortunately, several recent surveys have highlighted persistent variability in the care provided to this vulnerable population in the first hour of life.

Recent findings
Since its first adoption in the neonatal ICU (NICU) in 2009, published literature shows a consistent benefit in establishing a Golden Hour protocol. Improved short-term outcomes are reported, including reductions in hypothermia and hypoglycemia, efficiency in establishing intravenous access, and timely initiation of fluids and medications. Additionally, long-term outcomes report decreased risk for bronchopulmonary dysplasia (BPD), intraventricular hemorrhage (IVH) and retinopathy of prematurity (ROP).

Summary
Critical to the success and sustainability of any Golden Hour initiative is recognition of the continuous educational process involving multidisciplinary team collaboration to ensure coordination between providers in the delivery room and beyond. Standardization of practices in the care of extremely premature neonates during the first hour of life leads to improved outcomes.

Video Abstract
: http://links.lww.com/MOP/A68.

Keywords
extremely low-birth-weight neonates, extremely premature neonates, Golden Hour, outcomes

INTRODUCTION

Prematurity is the leading cause of neonatal mortality and contributes to ~50% of childhood disabilities in the United States [1]. Extremely premature (<27 weeks' gestation) and extremely low-birth-weight (<1000 g) (EP-ELBW) infants' mortality rates are 30–50%. Resuscitation in the delivery room and stabilization during neonatal ICU (NICU) admission involves a series of interdependent tasks and procedures that must be done efficiently and systematically. Due to the complexity of care required at birth, protocols including evidence-based practices with standardized application in the first hour of life have been applied to improve the quality and ensure the consistency of care for EP-ELBW infants.

BACKGROUND ON THE GOLDEN HOUR

The 'Golden Hour' adopted from the adult trauma literature [2,3] was first introduced in neonatology by Reynolds *et al.* [4] in 2009. This concept includes evidence-based interventions during the first 60 min of postnatal life to better support the fetal-to-neonatal transition, leading to better short-term and long-term outcomes, particularly for EP-ELBW and very-low-birth weight (VLBW) infants. Evidence-based interventions address predelivery planning, delivery room management, and neonatal resuscitation on NICU admission. Despite recommendations from

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KEY POINTS

- The Golden Hour, adopted from the adult trauma literature, was first introduced in neonatology by Reynolds *et al.* in 2009.
- Published literature shows a consistent benefit in establishing a Golden Hour protocol, improving short-term and long-term outcomes.
- This concept includes evidence-based interventions during the first 60 min of postnatal life to better support the fetal-to-neonatal transition.
- Despite recommendations from the International Liaison Committee on Resuscitation (ILCOR) and evidence for improved outcomes with standardized Golden Hour practices, recent surveys highlight persistent variability in the care within the first hour of life provided to this vulnerable population.

the International Liaison Committee on Resuscitation (ILCOR) and evidence for improved outcomes with standardized Golden Hour practices [5▪▪,6▪▪,7▪▪,8▪], recent surveys highlight persistent variability in the care within the first hour of life provided to this vulnerable population [9,10▪].

REVIEW OF GOLDEN HOUR COMPONENTS AND EVIDENCE

Predelivery planning

Antenatal counseling

Antenatal counselling, first introduced in the Neonatal Resuscitation Program (NRP) algorithm in 2015, is critical prior to an EP-ELBW infant delivery. The team leader, who may be the neonatal fellow in an academic setting, should meet with the parents to counsel them on outcomes, potential short-term and long-term complications related to extreme prematurity and anticipated NICU course [11]. Antenatal counselling can reduce parental anxiety and stress and increase satisfaction [12▪,13]. A shared decision-making (SDM) approach should be utilized for anticipated periviable deliveries. Additionally, communication with the obstetrics team is critical in preparing for such deliveries.

Neonatal resuscitation team role assignment

In 2006, the Vermont Oxford Network (VON) Neonatal Intensive Care Quality Improvement Collaborative recognized the importance of delivery room teamwork and communication for management of ELBW infants [14]. The neonatal resuscitation team leader should facilitate a predelivery huddle to discuss any significant antenatal history and assign roles and responsibilities for team members. Whenever delivery is expected, required delivery room equipment should be checked and prepared.

Delayed cord clamping

The total amount of whole blood in the fetal–placental circulation is 110–115 ml/kg of fetal body weight with about 30 ml/kg of this residing in the placenta. In 2015, the NRP guidelines began recommending delayed cord clamping (DCC), cord clamping after 30–180 s, for all premature infants not requiring immediate resuscitation [15]. Although DCC vs. early cord clamping is associated with need for fewer red blood cell transfusions, less intraventricular hemorrhage (IVH), and decreased necrotizing enterocolitis [16], umbilical cord milking has been shown to increase IVH rates in infants less than 32 weeks [17]. Confirmation of the plan to perform DCC should be communicated with the obstetrical team in the delivery room [18]. Ongoing research in this area seeks to address feasibility, benefits, and safety of bedside neonatal resuscitation with an intact umbilical cord [19].

Prevention of hypothermia

The incidence of hypothermia, defined as rectal temperature less than 36.5 °C, at NICU admission in VLBW infants is 31–78% [20–22]. Extremely premature infants are prone to hypothermia because of:

(1) Large body surface area to body mass ratio
(2) Very large area of the head
(3) Decreased subcutaneous fat
(4) Low levels of thermogenin and 5′3′ monodeiodinase
(5) Lower surge of thyrotropin
(6) Lack of shivering thermogenesis

After birth, the wet newborn may lose enough heat to decrease body temperature by 2–4 °C, with most heat lost in the first 10–20 min unless appropriate measures are taken. Heat loss in EP-ELBW infants occurs by four mechanisms: evaporation, radiation, conduction, and convection [23–25].

The ILCOR Neonatal Task Force systematic review, including evidence from 36 observational studies, reported increased risk of mortality associated with hypothermia at NICU admission. Eight

studies showed that a temperature less than 36 °C in preterm infants was independently associated with an increased IVH risk; nine studies showed an association with respiratory disease; seven studies showed a significant association with hypoglycemia; and two studies reported an association between admission hypothermia and development of late-onset sepsis [26]. The associated risks directly correlate with the degree of hypothermia and prematurity. Laptook *et al.* concluded that admission temperature was inversely related to mortality (28% increase in mortality per 1 °C decrease in temperature). The chance of early neonatal death was 1.64-fold higher in infants with admission temperatures less than 36 °C [21].

In 2012, the American Academy of Pediatrics/American College of Obstetricians and Gynecologists guidelines recommended maintaining an axillary temperature of approximately 36.5 °C for newborns in the delivery room [27]. To avoid hypothermia in the delivery room, it has been recommended to set the room temperature at 75–79 °F. The WHO advocates maintaining temperature in the delivery room at 25–28 °C (77–82 °F) [28,29]. The 2015 ILCOR recommendation is to maintain an environmental temperature for newly born nonasphyxiated infants, born 'less than 32 weeks of gestation between 23 and 25 °C (73–77 °F) [26]. The European Resuscitation guidelines recommend keeping the delivery room 23–25 °C (73–77 °F) for babies at least 28 weeks' gestation and more than 25 °C (>77 °F) for preterm infants less than 28 weeks' gestation [30].

Use of polyethylene bags and wraps

Beginning in 2005, ILCOR recommended placing extremely premature neonates immediately after birth in a polyethylene plastic wrap or a vinyl bag, without drying. All resuscitation procedures should be performed while the infant is in the plastic bag, including intubation and umbilical catheterization. Literature shows that use of these bags can significantly decrease the hypothermia incidence for EP-ELBW infants [31,32]. Total body wrapping was comparable to covering the body up to the shoulders in preventing postnatal thermal losses in very preterm infants [32]. One analysis concluded that the use of a polyethylene plastic bag immediately after birth prevents one case of hypothermia for every six wrapped infants [33]. Attention should be paid to monitoring for hyperthermia, as this has been shown to increase with the use of polyethylene wraps [33].

Additionally, use of plastic head coverings or hats is recommended over stocking-knit caps alone because of the superior ability to prevent heat loss [34]. A Cochrane metaanalysis concluded that plastic wraps or bags were effective in reducing heat losses in extreme premature infants (less than 28 weeks) but not in infants from 28 to 31 week's gestation [35]. Plastic caps were also effective in reducing heat losses in infants less than 29 weeks' gestation.

Thermal mattress

Thermal mattresses contain sodium acetate gel that crystallizes exothermically when activated, reaching 38–42 °C in approximately 90 s and maintaining that temperature for up to 2 h. Guidelines have recommended that thermal mattresses be used as an adjunct at the discretion of the stabilizing team to prevent hypothermia in infants born less than 32 weeks gestation. Although exothermic mattresses combined with polyethylene wraps may decrease the rate of hypothermia, they may also increase hyperthermia incidence, therefore, making close temperature monitoring a necessity whenever used [36,37].

Heated humidified gas source

Another important source of hypothermia in neonates is the respiratory tract. Heated humidified gas has been shown to support normothermia, presumably by decreasing evaporative loss from respiratory tract epithelium and convection losses that occur in infants inspiring cold air [38].

Prewarmed incubator

As soon as possible after birth, the newborn should be placed in a prewarmed double-walled incubator, having high air humidity (70–80%) and ambient temperature to mimic the fetal environment [39]. Ideally, infant transfers between beds should be limited. Whenever feasible, initial resuscitation may occur in a convertible isolette, with adjustable lid to facilitate access to the infant, while limiting subsequent bed transfers and infant exposure. A neonatal transport shuttle may be used to power the isolette and move from the labor room to the NICU; however, these items are costly and require a significant investment. Additionally, depending on institutional volume and acuity, bed transfers may still need to take place despite having access to this equipment, when multiple EP-ELBW infants deliver in a short span of time.

Prewarmed intravenous fluids

Providing cool or room temperature intravenous fluids may lead to inadvertent cooling of neonates, resulting in an increased chance of hypothermia. Although there are many interventions that have

been studied to provide improved thermal care to LBW neonates, intravenous fluid warmers have not received the attention it deserves, particularly in EP-ELBW infants, during NICU admission and transport [40▪].

Prevention of hypoglycemia

Hypoglycemia is common in growth-restricted and premature neonates. It is recognized that 23–50% of infants admitted to the NICU have one or more episodes of hypoglycemia [41]. With lower gestational age, adaptive mechanisms are not adequately developed, which predisposes this vulnerable population to increased risk of hypoglycemia.

During pregnancy, about 70% of the maternal glucose is allocated to the fetus while approximately 30% is consumed by the placenta [42]. Fetal glucose metabolism is regulated by fetal insulin production, which increases with pregnancy progression, enhancing glucose utilization by insulin-sensitive tissues, including skeletal muscle, liver, heart, and adipose tissue [43].

After birth, the placental supply of glucose ceases leading to a nadir in the first 2 h of life. This triggers release of counter regulatory hormones, important for gluconeogenesis within the first 6–24 h. A transient reduction in blood glucose values immediately after birth as part of transitional metabolic adaptation generally resolves within the first hours of life, and glucose levels gradually increase to reach adult values (blood glucose >70 mg/dl) within the first 72–96 h. Catecholamines play a crucial role by stimulating alpha receptors that help utilize brown fat and by promoting liver glycogenolysis and gluconeogenesis [44]. Hepatic glycogenolysis is the fastest mechanism that allows an increase of blood glucose levels after birth. However, the high rate of glycogenolysis leads to hastened depletion of hepatic glycogen stores, especially in preterm infants. In addition, gluconeogenesis is not immediately effective after birth and reaches its maturation capacity after 12 h [45]. In the meantime, hepatic ketogenesis markedly increases during the first hours after birth, to provide alternative fuels for brain metabolism in term infants. This metabolic pattern is severely limited in preterm infants because of a lack of fat stores in adipose tissue, which eventually results in failure of lipolysis [46].

There is no common consensus for defining euglycemia with different scientific organizations adopting different thresholds for hypoglycemia in neonates as summarized in Table 1.

Clinically, the association of hypoglycemia and neurodevelopmental abnormalities in preterm infants was defined as early as 1937 [53]. Many authors agree that severe, persistent hypoglycemia can cause seizures and brain injury; however, the prognostic meaning of transient hypoglycemia remains controversial. Though studies have shown hypoglycemia was not associated with an increased risk of neurosensory impairment, it was associated with an increased risk of low executive function and visual motor function, with the highest risk in

Table 1. Definition of hypoglycemia in neonates by different scientific organizations

Society	Recommended glucose threshold(s)	
	Hour of life	Recommended threshold
American Academy of Pediatrics (AAP) [47]	0–4 h	≥40 mg/dl*
	4–24 h	≥45 mg/dl postprandial
	≥48 h	≥60 mg/dl
	*Recommend treating blood glucose levels ≤40 mg/dl (mmol/l) parenterally	
Pediatric Endocrine Society (PES) [48]	0–48 h	<50 mg/dl
	>48 h	<60 mg/dl
Academy of Breastfeeding Medicine (ABM) [49]	0–2 h	≥28 mg/dl
	4–24 h	≥40 mg/dl postprandial
	48–72 h	≥48 mg/dl postprandial
British Association of Perinatal Medicine [50]	2–24 h	≥45 mg/dl postprandial if symptomatic *or* ≥36 if asymptomatic but with risk factors
Canadian Pediatric Society [51]	4–24 h	≥47 mg/dl postprandial
Swedish National Guidelines [52▪]	4–24 h	≥47 mg/dl postprandial
	≥72 h	≥54 mg/dl

Table 2. Evidence from previous Golden Hour projects

Study	Population and study characteristics	Parameters studied
Reynolds *et al.* (2008) [4]	Inborn neonates <32 weeks or less than <1500 g Initial GH process: 2001–2007 Revised GH process: 2007–2008	Increase in the median admission temperature during both initial and revised processes (36.2 vs. 36.7 °C) Decreased incidence of ROP and CLD in the revised GH period
Reuters *et al.* (2014) [66]	Neonates <29 weeks or <1000 g or any neonate who required considerable resuscitation (i.e. hydrops) 40 GH resuscitations	Decreased IVH rate (46 vs. 18%) Decreased time to vascular access (35 vs. 56 min) No difference in the minimum temperature reported, incidence of BPD, or length of hospital stay
Castrodale *et al.* (2014) [67]	Level III NICU Neonates <28 weeks Total of 225 infants 106 preprotocol 119 postprotocol	Increased infants with euthermia (36.5–37.4 °C) at admission (28.3 vs. 49.6%; $P=0.002$) Increased admission glucose >50 mg/dl (55.7 vs. 72%; $P=0.012$) Increased administration of i.v. glucose and amino acids within 1 h of life (7 vs. 61.3%; $P=0.001$)
Ashmeade *et al.* (2016) [45]	Neonates <28 weeks and/or <1000 g	Decreased time from birth to surfactant administration (79.8 ± 56.6 vs. 30.8 ± 21.8 min; $P<0.001$) Improved admission temperature ≥97.6 °F Decreased time to dextrose and amino acid administration (78.9 ± 43.3 vs. 27.4 ± 12.7 min; $P<0.001$) 64% reduction in the odds of developing CLD (OR = 0.36; 95% CI 0.17–0.74) 48% reduction in the odds of developing ROP (OR = 0.52, 95% CI 0.17–0.74)
Lambeth *et al.* (2016) [46]	56-bed level IIIB NICU Neonates < 1000 g	Decreased time to i.v. fluid administration (104 vs. 73.6 min; stabilized at 85.3 min) Decreased time to antibiotic administration (158.5 vs. 98.3 min) Upward trend of surfactant administration within the first 2 h of life
Lapcharoensap *et al.* (2017) [68]	California Perinatal Quality Care Collaborative: 95 hospitals 20 Collaborative QI 31 NICU QI 44 nonparticipant hospitals Compared baseline (January 2010 to May 2011; 4222 infants) vs. postintervention (June 2012 to May 2013; 4186 infants) periods Neonates 22 0/7–29 6/7 weeks and ≤500 g	Decreased odds of developing BPD (OR 0.8; 95% CI 0.65–0.99) and composite BPD-death (OR 0.83, 95% CI 0.69–1.00) Reduction in IVH, severe IVH, composite severe IVH-death, severe ROP, and composite severe ROP-death in collaborative QI and nonparticipant hospitals
Harriman *et al.* (2018) [69]	Large military hospital Inborn infants <32 weeks	Time to initiation of glucose-containing i.v. fluids decreased by 23 min Time to administration of ampicillin decreased by 14.6 min Time to administration of gentamicin decreased by 27 min
Croop *et al.* (2020) [70▪▪]	Inborn infants <27 weeks Data from 2012 to 2017 Three phases: Preprotocol ($n=80$) Phase I ($n=42$) Phase II ($n=92$)	Decreased hypothermia (59 vs. 26 vs. 38%; $P=0.001$) Decreased hypoglycemia (18 vs. 7 vs. 4%; $P=0.012$) Decreased time (minutes) to completion of stabilization [110 (89,138) vs. 111 (94,135) vs. 92 (74,129); $P=0.0035$]
Dylag *et al.* (2021) [71▪▪]	68-bed, level IV NICU Neonates ≤29 weeks	Decreased rate of CLD from 33.5 to 16.5% Percentage of infants born ≤28 weeks receiving prophylactic surfactant in the delivery room increased from 80.8% to 98.1%

BPD, bronchopulmonary dysplasia; CI, confidence interval; CLD, chronic lung disease; i.v., intravenous; IVH, intraventricular hemorrhage; OR, odds ratio; QI, quality improvement; ROP, retinopathy of prematurity.

Table 3. Timeline for Golden Hour interventions in our level III neonatal ICU

	Fellow/attending	RNs	APPs	Resident	RT
Pre-delivery	Notified of impending delivery by OB. Review maternal chart/history and inform the attending. Notifies team. Consult if needed. Huddle with team (admit RN, advance practice providers (APP), resident and respiratory therapist (RT)) to assign roles. Notify the unit clerk of impending delivery Discuss collection of admission labs from cord blood: CBC, blood culture, blood gas, type and Coombs)	Ensures admit preheated incubator is ready. - Ensures DR equipment is available. - Check delivery room temperature (73–77° F). - Turn radiant warmer on. - Ensure warm blankets, activates thermal mattress on the bed. - Sterilely open the plastic bag and deposit it in the surgical filed at the direction of the OB scrub nurse.	Gather umbilical line supplies and set up tray	If no APP available, second resident remains in NICU for orders	Check Neopuff, source, oxygen supply, appropriate size mask and suction. The RT should connect the bubble CPAP heater to the transport shuttle prior to transport. Ensure appropriate intubation and CPAP supplies are at bedside. Adjust pressures of Neopuff at PIP 20, PEEP 5) RT in the NICU to setup respiratory equipment in the NICU.
0–10 min	Head of bed for resuscitation. Leads resuscitation per NRP guidelines.	Place baby in the plastic bag. Assess heart rate and inform the team until stable. - Place skin temp probe. - Make sure silo bag is appropriately covering baby - Hat is in place	Available to attend delivery if additional assistance is needed.	Attend delivery Place plastic lined hat on baby's head. Performs neonatal resuscitation under supervision of the fellow. Assign Apgar scores.	Place pulse oximetry on the right wrist. Place EKG leads as per NRP. Adjust FiO_2 to maintain saturations within target NRP ranges. Monitor Neopuff pressures and ensure adequate seal.
10–15 min	Stabilize infant for transport to NICU. Update family. Make sure admission labs are collected from cord blood	Prepare infant for transport to NICU. - Obtain axillary temperature of the baby. - Confirm ID bands and communicate axillary temperature to the OB RN for documentation. - Place identification bands prior to transport.	Calls the unit clerk to expedite entry of the baby in the system. Enter weight. Begin order set placement once weight is called from DR. Orders and calls for CXR if infant is intubated. Calls pharmacy to alert of Golden hour admission	Calls weight and other obtained measurements to NICU	Make sure ETT position is appropriate Call for surfactant if infant is intubated after approval of the fellow (as per unit respiratory guidelines)
15–25 min	Prepare for umbilical line if assigned to place. Confirm appropriate ETT/line placement on X ray. Monitor blood gases and make necessary adjustment/escalation	Perform immediate admission assessment. - Place a note on the bed It is my golden hour at bedside to remind providers. - Administer Vitamin K and erythromycin. - Place peripheral i.v., obtain first blood sugar, axillary temperature and initiate D10W. - Place NG if on bCPAP.	Prepare for umbilical line if assigned to place. - Back up to place PIV. May initiate UA/UV placement at this stage if unable to obtain PIV.	Prepare to observe/assist with line placement	Administer surfactant s/p CXR if indicated. Follow gentle ventilation strategies if invasive ventilation is required.
25–45 min	Umbilical line placement. Obtain ordered labs (type and screen, peripheral blood gas, CBC, blood culture). NOT needed if sent from cord blood	Prepare central line fluids. - Call for CXR Ensure antibiotics are available if ordered.	Umbilical line placement. Obtain ordered labs	Observe/assist with line placement	Continue to wean oxygen and run first ABG/CBG
45–55 min	Secure lines following confirmed placement. Perform assessment if needed	Initiate line fluids and D/C PIV fluids. Administer antibiotics if ordered. Administer indomethacin if appropriate	Secure lines following confirmed placement.		Perform check (ETT placement) prior to incubator closure.
55–60 min	Update family	Finish any remaining tasks. - Ensure proper servo and humidity settings. Obtain temperature and close incubator. Fill out checklist	Ensure checklist has been completed.		

CXR, Chest X-ray; CPAP, continuous positive pressure ventilation; ETT, Endotracheal tube; OB RN, Obstetric registered nurse; PIV, Peripheral intravenous access.

children exposed to severe, recurrent, or clinically undetected hypoglycemia [54,55].

Timely establishment of intravenous access and initiation of dextrose containing fluids in the first few minutes of life, is critical in EP-ELBW to avoid hypoglycemia. Establishing peripheral access as a bridge prior to umbilical line placement can help avoid this complication.

Respiratory management in the delivery room

Noninvasive ventilation in the form of continuous positive pressure ventilation (CPAP) is currently recommended in the delivery room by both the Committee on the Fetus and Newborn and NRP [56,57]. CPAP leads to maintenance of the functional residual capacity of the lung, which can reduce the need for intubation, exogenous surfactant, postnatal corticosteroids, and total ventilator days [58]. Large multicenter trials have supported the initial use of CPAP in the delivery room within the first 15 min after birth [59–63], with a Cochrane review of 3201 babies from 24 to 32 weeks gestation suggesting a reduction in BPD and mortality [64▪]. For infants with respiratory distress syndrome (RDS), early surfactant administration with brief mechanical ventilation followed by extubation (INSURE method) vs. later selective surfactant and continued mechanical ventilation was shown to be successful in reducing the need of mechanical ventilation and BPD rates [65].

EVIDENCE FROM PREVIOUS GOLDEN HOUR PROJECTS

Several centers have published data from implementation of Golden Hour in neonatology with the first publication by Reynolds *et al.* in 2009 [4]. A summary of the findings of these studies are included in Table 2.

Our center Golden Hour protocol

Included below is the protocol used in our 75-bed level III NICU. In addition to a literature review, this project was developed in collaboration with our obstetric team, pharmacy, radiology, and information technology to develop consensus management guidelines. A Golden Hour order set to expedite order entry, while minimizing errors, was incorporated in the electronic medical record. Educational sessions were provided to the nurses, respiratory therapists, residents, advanced practice providers, fellows, and attendings. Live reports are used for ongoing data collection to track progress (Table 3).

CONCLUSION

A coordinated focus on the Golden Hour in EP-ELBW neonates has been shown to improve short-term and long-term outcomes. Critical to the success of any Golden Hour initiative is recognition of the continuous educational process that involves collaboration between multidisciplinary teams to ensure coordination between different providers in the delivery room and beyond. Adequately supporting our extremely premature neonates in the immediate postnatal period is the first step to decrease morbidity and mortality in this vulnerable population.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- ▪ of special interest
- ▪▪ of outstanding interest

1. Stoll BJ, Hansen NI, Bell EF, *et al.* Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. Neonatal outcomes of extremely preterm infants from the NICHD Neonatal Research Network. Pediatrics 2010; 126:443–456.
2. Lerner EB, Moscati RM. The golden hour: scientific fact or medical ''urban legend''? Acad Emerg Med 2001; 8:758–760.
3. Sasada M, Williamson K, Gabbott D. The golden hour and prehospital trauma care. Injury 1995; 26:215–216.
4. Reynolds RD, Pilcher J, Ring A, *et al.* The Golden Hour: care of the LBW infant during the first hour of life one unit's experience. Neonatal Netw 2009; 28:211–219.
5. ▪▪ Kusuda S, Hirano S, Nakamura T. Creating experiences from active treatment towards extremely preterm infants born at less than 25 weeks in Japan. Semin Perinatol 2022; 46:151537.

Recent study highlighting improved outcomes in periviable neonates with increased experiences and standardization of practices.

6. ▪▪ Pavlek LR, Mueller C, Jebbia MR, *et al.* Perspectives on developing and sustaining a small baby program. Semin Perinatol 2022; 46:151548.

A recent study looking at the value of establishing a small baby program including development of a Golden Hour protocol and its association with improved outcomes.

7. ▪▪ Dagle JM, Rysavy MA, Hunter SK, *et al.* Cardiorespiratory management of infants born at 22 weeks' gestation: the Iowa approach. Semin Perinatol 2022; 46:151545.

An important study highlighting the Iowa approach associated with improved outcomes in periviable neonates, a part of which is related to standardized practices in the immediate delivery period and beyond.

8. ▪ Ricci MF, Shah PS, Moddemann D, *et al.* Neurodevelopmental outcomes of infants at <29 weeks of gestation born in Canada between 2009 and 2016. J Pediatr 2022; 247:60.e1–66.e1.

Recent study looking at improved outcomes in premature neonates and its association with implementation of Golden Hour.

9. Shah V, Hodgson K, Seshia M, *et al.* Golden hour management practices for infants <32 weeks gestational age in Canada. Paediatr Child Health 2018; 23:e70–e76.
10. ▪ Hodgson KA, Owen LS, Lui K, Shah V. Neonatal Golden Hour: a survey of Australian and New Zealand Neonatal Network units' early stabilisation practices for very preterm infants. J Paediatr Child Health 2021; 57:990–997.

Important survey highlighting the variation persistent in practices, despite strong recommendations for adopting Golden Hour protocols in extremely premature neonates.

11. Wyckoff MH. Initial resuscitation and stabilization of the periviable neonate: the Golden-Hour approach. Semin Perinatol 2014; 38:12–16.
12. ■ Fish R, Weber A, Crowley M, *et al.* Early antenatal counseling in the outpatient setting for high-risk pregnancies: a randomized control trial. J Perinatol 2021; 41:1595–1604.

This study highlights the importance of antenatal counselling in predelivery planning of extremely premature neonates.

13. Wyckoff MH, Aziz K, Escobedo MB, *et al.* Part 13: neonatal resuscitation: 2015 American Heart Association Guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2015; 132(18 Suppl 2):S543–S560.
14. Ohlinger J, Kantak A, Lavin JP Jr, *et al.* Evaluation and development of potentially better practices for perinatal and neonatal communication and collaboration. Pediatrics 2006; 118(Suppl 2):S147–S152.
15. Wyckoff MH, Aziz K, Escobedo MB, *et al.* Part 13: neonatal resuscitation: 2015 American Heart Association Guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care (reprint). Pediatrics 2015; 136(Suppl 2):S196–S218.
16. Rabe H, Diaz-Rossello JL, Duley L, Dowswell T. Effect of timing of umbilical cord clamping and other strategies to influence placental transfusion at preterm birth on maternal and infant outcomes. Cochrane Database Syst Rev 2012; (8):CD003248.
17. Katheria A, Reister F, Essers J, *et al.* Association of umbilical cord milking vs delayed umbilical cord clamping with death or severe intraventricular hemorrhage among preterm infants. JAMA 2019; 322:1877–1886.
18. Aziz K, Lee HC, Escobedo MB, *et al.* Part 5: Neonatal Resuscitation: 2020 American Heart Association Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2020; 142(16 Suppl 2): S524–S550.
19. Katheria AC, Sorkhi SR, Hassen K, *et al.* Acceptability of bedside resuscitation with intact umbilical cord to clinicians and patients' families in the United States. Front Pediatr 2018; 6:100.
20. Bhatt DR, White R, Martin G, *et al.* Transitional hypothermia in preterm newborns. J Perinatol 2007; 27(Suppl 2):S45–S47.
21. Laptook AR, Salhab W, Bhaskar B; Neonatal Research Network. Admission temperature of low birth weight infants: predictors and associated morbidities. Pediatrics 2007; 119:e643–e649.
22. Trevisanuto D, Testoni D, de Almeida MFB. Maintaining normothermia: why and how? Semin Fetal Neonatal Med 2018; 23:333–339.
23. Szymankiewicz M. Thermoregulation and maintenance of appropriate temperature in newborns. Ginekol Pol 2003; 74:1487–1497.
24. Watkinson M. Temperature control of premature infants in the delivery room. Clin Perinatol 2006; 33:43–53; vi.
25. Motherhood. WHOMaNHS. Thermal protection of the newborn: a practical guide. Geneva: WHO; 1997. 1997.
26. Perlman JM, Wyllie J, Kattwinkel J, *et al.* Neonatal Resuscitation Chapter Collaborators. Part 7: Neonatal Resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2015; 132(16 Suppl 1):S204–S241.
27. and AAoPaACoO, Gynecologists. Guidelines for perinatal care. 2012. Seventh edition.
28. WHO. Thermal control of the newborn: a practical guide. Maternal Health and Safe Motherhood Programme. 1996.
29. Thermal protection of the newborn: a practical guide (WHO/RHT/MSM/97.2). [press release]. 1997.
30. Wyllie J, Bruinenberg J, Roehr CC, *et al.* European Resuscitation Council Guidelines for Resuscitation 2015: Section 7. Resuscitation and support of transition of babies at birth. Resuscitation 2015; 95:249–263.
31. Lenclen R, Mazraani M, Jugie M, *et al.* Use of a polyethylene bag: a way to improve the thermal environment of the premature newborn at the delivery room. Arch Pediatr 2002; 9:238–244.
32. Doglioni N, Cavallin F, Mardegan V, *et al.* Total body polyethylene wraps for preventing hypothermia in preterm infants: a randomized trial. J Pediatr 2014; 165:261.e1–266.e1.
33. Li S, Guo P, Zou Q, *et al.* Efficacy and safety of plastic wrap for prevention of hypothermia after birth and during NICU in preterm infants: a systematic review and meta-analysis. PLoS One 2016; 11:e0156960.
34. Trevisanuto D, Doglioni N, Cavallin F, *et al.* Heat loss prevention in very preterm infants in delivery rooms: a prospective, randomized, controlled trial of polyethylene caps. J Pediatr 2010; 156:914.e1–917.e1.
35. McCall EM, Alderdice F, Halliday HL, *et al.* Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants. Cochrane Database Syst Rev 2010; (3):CD004210.
36. Singh A, Duckett J, Newton T, Watkinson M. Improving neonatal unit admission temperatures in preterm babies: exothermic mattresses, polythene bags or a traditional approach? J Perinatol 2010; 30:45–49.
37. McCarthy LK, Molloy EJ, Twomey AR, *et al.* A randomized trial of exothermic mattresses for preterm newborns in polyethylene bags. Pediatrics 2013; 132: e135–e141.
38. Trevisanuto D, Sedin G. Physical environment for newborns: the thermal environment. In: Buonocore G, Bracci R, Weindling M, editors. Neonatology. Cham: Springer; 2018.
39. Meyer MP, Bold GT. Admission temperatures following radiant warmer or incubator transport for preterm infants <28 weeks: a randomised study. Arch Dis Child Fetal Neonatal Ed 2007; 92:F295–297.
40. ■ Giang LeHa MTM, Lois Kwon BS, Jeffrey Lubin MDM. Warmed IV fluids to neonates. Air Med J 2022; 41:26–27.

Recent study highlighting the importance of warming intravenous fluids during transport.

41. Harris DL, Weston PJ, Harding JE. Incidence of neonatal hypoglycemia in babies identified as at risk. J Pediatr 2012; 161:787–791.
42. Michelsen TM, Holme AM, Holm MB, *et al.* Uteroplacental glucose uptake and fetal glucose consumption: a quantitative study in human pregnancies. J Clin Endocrinol Metab 2019; 104:873–882.
43. Hay WW Jr. Energy and substrate requirements of the placenta and fetus. Proc Nutr Soc 1991; 50:321–336.
44. Hume R, Pazouki S, Hallas A, Burchell A. The ontogeny of the glucose-6-phosphatase enzyme in human embryonic and fetal red blood cells. Early Hum Dev 1995; 42:85–95.
45. Ashmeade TL, Haubner L, Collins S, *et al.* Outcomes of a neonatal Golden Hour Implementation Project. Am J Med Qual 2016; 31:73–80.
46. Lambeth TM, Rojas MA, Holmes AP, Dail RB. First Golden Hour of life: a quality improvement initiative. Adv Neonatal Care 2016; 16:264–272.
47. Thompson-Branch A, Havranek T. Neonatal hypoglycemia. Pediatr Rev 2017; 38:147–157.
48. Thornton PS, Stanley CA, De Leon DD, *et al.* Pediatric Endocrine Society. Recommendations from the Pediatric Endocrine Society for Evaluation and Management of Persistent Hypoglycemia in Neonates, Infants, and Children. J Pediatr 2015; 167:238–245.
49. Wight N, Marinelli KA; Academy of Breastfeeding Medicine. ABM clinical protocol #1: guidelines for blood glucose monitoring and treatment of hypoglycemia in term and late-preterm neonates, revised 2014. Breastfeed Med 2014; 9:173–179.
50. Hawdon JM. Identification and management of neonatal hypoglycemia in the full-term infant. British Association of Perinatal Medicine Framework for Practice, 2017. J Hum Lact 2019; 35:521–523.
51. Narvey MR, Marks SD. The screening and management of newborns at risk for low blood glucose. Paediatr Child Health 2019; 24:536–554.
52. ■ Wackernagel D, Gustafsson A, Edstedt Bonamy AK, *et al.* Swedish national guideline for prevention and treatment of neonatal hypoglycaemia in newborn infants with gestational age >/=35 weeks. Acta Paediatr 2020; 109: 31–44.

Recent guidelines for prevention of hypoglycemia according to the Swedish guidelines.

53. Sharma A, Davis A, Shekhawat PS. Hypoglycemia in the preterm neonate: etiopathogenesis, diagnosis, management and long-term outcomes. Transl Pediatr 2017; 6:335–348.
54. McKinlay CJ, Alsweiler JM, Ansell JM, *et al.* CHYLD Study Group. Neonatal glycemia and neurodevelopmental outcomes at 2 years. N Engl J Med 2015; 373:1507–1518.
55. McKinlay CJD, Alsweiler JM, Anstice NS, *et al.* Association of neonatal glycemia with neurodevelopmental outcomes at 4.5 years. JAMA Pediatr 2017; 171:972–983.
56. Perlman JM, Wyllie J, Kattwinkel J, *et al.* Neonatal Resuscitation Chapter Collaborators. Part 7: Neonatal Resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations (Reprint). Pediatrics 2015; 136(Suppl 2):S120–S166.
57. Committee on FN, American Academy of Pediatrics. Respiratory support in preterm infants at birth. Pediatrics 2014; 133:171–174.
58. Carlo WA. Gentle ventilation: the new evidence from the SUPPORT, COIN, VON, CURPAP, Colombian Network, and Neocosur Network trials. Early Hum Dev 2012; 88(Suppl 2):S81–S83.
59. Dunn MS, Kaempf J, de Klerk A, *et al.* Randomized trial comparing 3 approaches to the initial respiratory management of preterm neonates. Pediatrics 2011; 128:e1069–e1076.
60. Finer NN, Carlo WA, Duara S, *et al.* National Institute of Child Health and Human Development Neonatal Research Network. Delivery room continuous positive airway pressure/positive end-expiratory pressure in extremely low birth weight infants: a feasibility trial. Pediatrics 2004; 114: 651–657.
61. Finer NN, Carlo WA, *et al.* SUPPORT Study Group of the Eunice Kennedy Shriver NICHD Neonatal Research Network. Early CPAP versus surfactant in extremely preterm infants. N Engl J Med 2010; 362:1970–1979.
62. te Pas AB, Spaans VM, Rijken M, *et al.* Early nasal continuous positive airway pressure and low threshold for intubation in very preterm infants. Acta Paediatr 2008; 97:1049–1054.
63. Morley CJ, Davis PG, Doyle LW, *et al.* COIN Trial Investigators. Nasal CPAP or intubation at birth for very preterm infants. N Engl J Med 2008; 358: 700–708.
64. ■ Subramaniam P, Ho JJ, Davis PG. Prophylactic or very early initiation of continuous positive airway pressure (CPAP) for preterm infants. Cochrane Database Syst Rev 2021; 10:CD001243.

Cochrane review highlighting the benefits of CPAP in preterm infants as initial noninvasive respiratory support in the delivery room.

65. Stevens TP, Harrington EW, Blennow M, Soll RF. Early surfactant administration with brief ventilation vs. selective surfactant and continued mechanical ventilation for preterm infants with or at risk for respiratory distress syndrome. Cochrane Database Syst Rev 2007; (4): CD003063.
66. Reuter S, Messier S, Steven D. The neonatal Golden Hour–intervention to improve quality of care of the extremely low birth weight infant. S D Med 2014; 67:397–403; 405.
67. Castrodale V, Rinehart S. The golden hour: improving the stabilization of the very low birth-weight infant. Adv Neonatal Care 2014; 14:9–14.
68. Lapcharoensap W, Bennett MV, Powers RJ, *et al.* Effects of delivery room quality improvement on premature infant outcomes. J Perinatol 2017; 37:349–354.
69. Harriman TL, Carter B, Dail RB, *et al.* Golden hour protocol for preterm infants: a quality improvement project. Adv Neonatal Care 2018; 18:462–470.
70. ■■ Croop SEW, Thoyre SM, Aliaga S, *et al.* The Golden Hour: a quality improvement initiative for extremely premature infants in the neonatal intensive care unit. J Perinatol 2020; 40:530–539.
This study highlights the impact of the Golden hour on improved short-term outcomes in neonates born less than 27 weeks.
71. ■■ Dylag AM, Tulloch J, Paul KE, Meyers JM. A quality improvement initiative to reduce bronchopulmonary dysplasia in a level 4 NICU-Golden Hour management of respiratory distress syndrome in preterm newborns. Children (Basel) 2021; 8.
This study highlights the impact of Golden Hour implementation in neonates born less than 25 weeks on decreased risk for BPD.