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Original article

Effect of head-elevated prone position care for stable term neonates with tachypnea in transitional period: A randomized controlled trial

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Abstract

Background: Rapid shallow breathing in 2 - 6 hours after birth or transitional period is usually physiologic. Infants who still have respiratory rate over 60 breaths per minutes after two hours supportive care at Sirindhorn labor room must be admitted as sick newborn. This may cause an unnecessary admission and increase the risk of breastfeeding failure.

Objectives: Primary objective was to evaluate the benefit of prone position in reducing respiratory rate to ≤ 60 breaths per minute especially when complete two hours labor room treatment. Secondary objective was to compare the infants' normal body temperature (36.5 - 37.5 °C) and optimum infants' body temperature (36.8 - 37.2 °C) caring in different positions at two hours of age.

Methods: Two hundred subjects were randomized into head-elevated prone group and supine-positioned group. The subjects were term Thai neonate with stable tachypnea in transitional period. Both groups were received the same supporting care except for the care positions. The subjects' respiratory rate and the relation between the duration were monitored and analyzed for normal respiratory rate and difference in positional care.

Results: The duration used for normal respiratory rate in a head-elevated prone group was significantly shorter than a supine-positioned group ($P = 0.0004$). Head-elevated prone care significantly increased cumulative number of subjects with normal respiratory rate within four hours ($P = 0.01$) and within six hours ($P = 0.002$) but no significant increase in cumulative number of subjects with normal respiratory rate within two hours ($P = 0.234$). At aged two hours, both groups had normothermia but the head-elevated prone group had more optimum body temperature range ($P = 0.02$).

Conclusion: Head-elevated prone position care for stable term neonate with tachypnea in transitional period can significantly decrease infants' respiratory rate within four hours compared to supine-positioned care.

Keywords: Optimum temperature tachypnea, normal infants' respiratory rate, normal infants' temperature, term infant, transition period.

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Transition from fetus to survive in extrauterine life is the critical period in all neonates. Major immediate adaptations are the respiratory system simultaneously with cardiovascular system. Other adaptations are endocrine function and thermogenesis. [1, 2] The peak period of respiratory adaptation occurs within 2 - 6 hours after birth. In the first 30 minutes of life, infants usually have rapid shallow breathing (tachypnea without dyspnea) respiratory rate about 60 - 80 breaths per minute. Then infants breathe slower and more regularly to normal respiratory rate 40 - 60 breaths per minute within 2 - 6 hours after birth. [1, 2] Heart rate, skin color, motor activity, bowel movement are also stabilized within 6 hours after birth. [1 - 4] In transitional period, infants need appropriate care including temperature management, respiratory care, circulatory management, blood glucose monitoring and management in order to support their efficient adaptations leading to normally decrease in pulmonary pressure which can prevent the most serious complication of maladaptation called persistent pulmonary hypertension of the newborn (PPHN).[5] Although infants have normothermia, they might have tachypnea if they are not in optimum temperature which is 37.0 ± 0.2°C.[6]

Many literatures support caring stable neonates with tachypnea in transitional period by prone position which more benefits in decreasing respiratory rate, decreasing metabolic rate, reducing body surface area to expose the environment then preventing heat loss and improving thermoregulation than caring in supine position.[1, 7] The mechanisms which prone position decreasing respiratory rate include the fact that: 1) Prone position decreases transpulmonary pressure, increases elasticity, improves compliance resulting in increasing functional residual capacity and improving lung function.[8] ; 2) Prone position improves diaphragmatic contraction, rib cage expansion which lead to improving thoraco-abdominal synchrony.[9, 10] ; 3) Prone position improves oxygenation [11 - 14] by increasing functional residual capacity, improving lung expansion, [12] opening of dorsal lungs [12, 13] and yielding to easier in secretion drainage.[13, 14] These results improve ventilation-perfusion matching and oxygenation; 4) Prone position decreases energy expenditure [15] by lowering infant body surface area exposed to the environment, keeping the infants calm which support efficient adaptations; and 5) Prone position may enhance respiratory control by increasing hypercapnic ventilatory response [16 - 18] although some literatures report no conclusion in this benefit especially in preterm neonates.[17]

The pediatric patient care team of Sirindhorn Hospital had a protocol treatment of stable term neonates with rapid shallow breathing respiratory rate above 60 breaths per minute without increase work of breathing (stable tachypnea) in transitional period. This protocol included close observation infants' respiratory rate for two hours under radiant warmer in labor room, checking capillary blood glucose (CBG) and hematocrit (Hct), treatment of hypothermia, hypoglycemia, polycythemia and anemia as indicated. In case of abnormal conditions as mentioned these sick infants would be transferred to special care nursery before complete 2 hour observation. Infants with rapid shallow breathing without problems in temperature, hypoglycemia, polycythemia and anemia will be observed until complete 2 hours of age. If the infants 'respiratory rates are ≤ 60 breaths per minute then they would stay with their mothers, but if their respiratory rates are still above 60 breaths per minute, then they would be admitted to the special care nursery.

Sirindhorn Hospital is a tertiary hospital of Bangkok metropolitan administration, Thailand where number of neonatal birth average 3,000 cases per year (since 2017 - 2022). The Hospital has 6-bed neonatal intensive care unit (NICU) which is in standard (average 500 birth: 1 NICU bed). However, there are insufficient special care nursery beds due to limitation in the number of nursing staffs. Increasing special care nursery beds is unlikely to be possible in short term management. The appropriate care technique of stable term neonates with tachypnea in transitional period can solve this problem. If the care technique can reduce infants' respiratory rates within two hours, those infants do not need to be admitted to special care nursery. The infants could stay with their mothers preventing unnecessary treatments (i.e. intravenous antibiotic) in case of delayed adaptation and enhancing successfulness in breastfeeding. [19] Furthermore, appropriate care in transitional period especially respiratory care, temperature management, circulatory management, blood glucose management and keeping the infant in calm situation can prevent PPHN which is the leading cause of term neonatal death in Sirindhorn Hospital.

The objective of this study was to evaluate whether head-elevated prone position care in

transitional period can reduce infants' respiratory rates ≤ 60 breaths per minute at 2 hours of age compare to supine-positioned care in term stable tachypnic infants.

This study also aimed to compare the infants' normal body temperature (36.5 - 37.5°C) and optimum infants' body temperature (37.0 ± 0.2°C) at 2 hours of age between head-elevated prone position care and supine-positioned care.

Materials and methods

This study is a single center randomized controlled trial, examined in labor room, special care nursery and NICU of Sirindhorn Hospital during April 2020 to December 2022.After approval of the Human research ethics committee of Bangkok metropolitan administration (S016h/62). Written informed consent was acquired from the parents of the subjects in accordance with the ethical principles of the Helsinki declaration. Inclusion criteria were inborn term Thai neonates who have stable rapid shallow breathing respiratory rates more than 60 breaths per minute and onset of tachypnea within two hours after birth. Exclusion criteria were major congenital anomaly, labile hypoxemia at 30 minutes of age, 10 minute preductal oxygen saturation ≤ 85.0%, need for invasive and noninvasive ventilation, needs for chest compression, fluid resuscitation, blood component transfusion or exchange, moderate to severe hypoxic ischemic encephalopathy (HIE), sudden infant death syndrome (SIDS), severe hypothermia (body temperature < 35°C), parental consent rejection. Posters and brochures were publicized at Sirindhorn Antenatal Care Clinic and subject information sheets were also given to pregnant women since they visited antenatal care clinic. When term Thai pregnant women arrived at a labor room for delivery, pediatric intern gave the information of the study to the pregnant women in latent phase. Consent forms were signed by women or their husbands if they allowed their baby to participate as subjects. Subjects were randomized to the study group (head-elevated prone group) and control group (supine-positioned group) by block of four technique. If the subjects had signs or symptoms of worsened work of breathing during the study, the pediatrician would promptly evaluate, gave proper management and withdrew the subjects from the study. Both study group and control group were treated by the same general neonatal care guidelines including neonatal resuscitation [20], neonatal hypoglycemia guideline (by Sirindhorn pediatric patient care team), thermoregulation guideline (by Sirindhorn pediatric patient care team), polycythemia and anemia guideline (by Sirindhorn pediatric patient care team).

The care process in transitional period was set up. This care process was responsible by labor nursing staff who accomplished yearly certificated neonatal resuscitation program.The care process was as follows. First, clean, clamp and cut umbilical cord 2-centimeters long by sterile technique then clean eyes and give vitamin K injection. After that standard rectal temperature and respiratory rate were measured and preductal oxygen saturation was continuously monitored. If infants' respiratory rate were above 60 breaths per minute, promptly notify a pediatrician and check CBG as well as Hct (no. 2 Terumo lancets were applied). Treat hypoglycemia, hypothermia, polycythemia or anemia as indicated. In this step, infants who had tachypnea due to hypoglycemia, severe hypothermia, needs of blood exchange or transfusion would be excluded from the study.

Subjects randomized as study group were care in head elevated (15 degree) prone position under radiant warmer. Infants were tilted their faces to let the attending nurses observe nasal flaring, nasal obstruction and lips color clearly. A skin servo control probe was attached on infants' back (below the scapular area) and set skin temperature of 36.5°C. Put on head cap and continuously monitor preductal oxygen saturation for two hours. Respiratory rate and axillary temperature were evaluated every 30 minutes to one hour until aged two hours.

Subjects randomized as control group were cared in supine position under radiant warmer with other treatments and monitoring procedures were the same as study group, except for the care position. (The skin servo control probe was attached on right upper quadrant of infant's abdomen and set skin temperature of 36.5°C)

During 2 hour observation, if the infants had signs or symptoms of worsened work of breathing, the pediatrician would promptly evaluate, gave proper management and withdrew the subjects from the study.

At aged two hours if the infant had normal temperature, no hypoglycemia and respiratory rate ≤ 60 breaths per minute, the infants would stay with their mothers at postpartum ward. Duration used for respiratory rate ≤ 60 breaths per minute and body temperature stability in 2 hours were compared

between a head-elevated prone group and a supine-positioned group. The infants at postpartum ward were followed at least six hours for complication such as persistent pulmonary hypertension of the newborn (PPHN), respiratory failure.

At aged two hours, if the infant had normal temperature, no hypoglycemia but respiratory rate over 60 breaths per minute then admit infant to special care nursery or NICU and give specific treatment which care position of subjects in special care nursery or NICU depends on the infant's randomized group "study group" and "control group". The infants were followed until their respiratory rates are ≤ 60 breaths per minute, record the duration used, record the definite diagnosis (ICD10), complications such as PPHN, respiratory failure and compare duration used for respiratory rate ≤ 60 breaths per minute between a head-elevated prone group and a supine-positioned group (**Figure 1**).

Statistical analysis

Baseline characteristics, duration used for respiratory rate ≤ 60 breaths per minute, body temperature at aged 30 minutes, one hour, two hours of each group were expressed as percentage and mean ± standard deviation (SD). Variables between 2 groups were analyzed by Chi-square test (categorical variables), Student *t* - test (normally distributed continuous outcome variables), Mann-Whitney *U* - test (non-parametric continuous outcome variables). $P < 0.05$ was considered statistically significant.

Results

Total subjects of 200 infants were divided into two groups. One hundred infants were randomized in a head-elevated prone group, the other one hundred infants were randomized in a supine-positioned group. Baseline characteristics of the subjects including gestational age, birth weight, gender, route of delivery, Apgar score, maternal risks and onset of rapid shallow breathing are shown in **Table 1**.

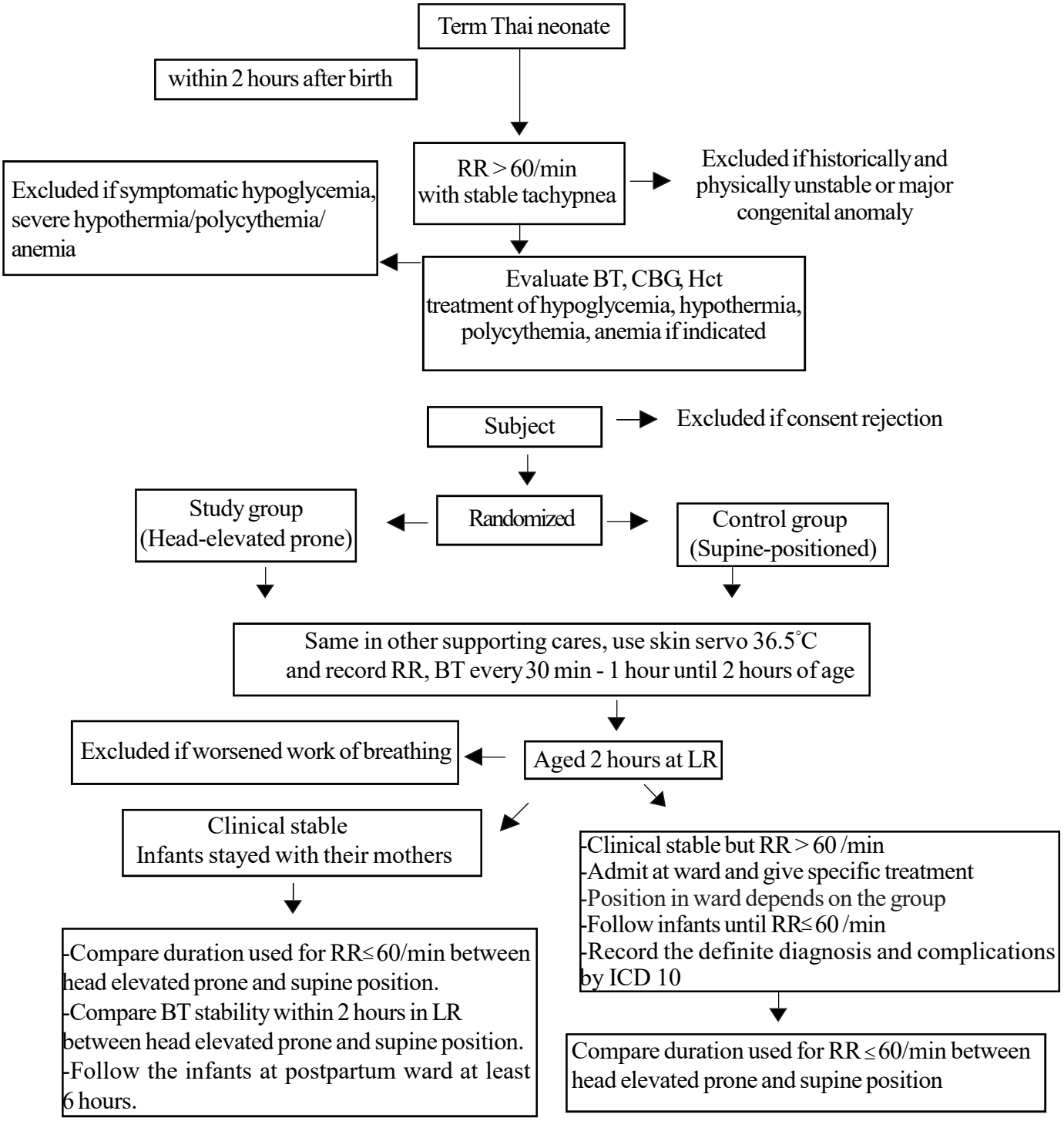
The majority of the subjects in both groups need admissions based on 2 hour respiratory rate in labor room. The difference in positional care significantly affected further investigation ($P = 0.03$), definite diagnosis ($P = 0.005$), duration of tachypnea or duration used for respiratory rate ≤ 60 breaths per minute ($P = 0.0004$).

The subjects in the head-elevated prone group mainly tested for CBG, Hct only (62.0%) while the subjects in a supine- positioned group received full investigations (54.0%). The subjects in a head-elevated prone group mainly received definite diagnosis of tachypnea in adaptation (adaptation and delayed adaptation = 69.0%) and the duration used for respiratory rate ≤ 60 breaths per minute in a head-elevated prone group (340.4 minutes) was shorter than a supine-positioned group (685.5 minutes). The data of subject's tachypnic characteristics are as shown in **Table 2**.

Comparing between positional cares and duration used for respiratory rate ≤ 60 breaths per minute especially within 2 - 6 hours which is the critical period in transitional process, we found that within four hours the head-elevated prone group had more significant cumulative number of subjects with normal respiratory rate (63 subjects in a head-elevated prone group compared to 44 subjects in a supine-positioned group, $P = 0.01$) and within six hours the head-elevated prone group had more significant cumulative number of subjects with normal respiratory rate (70 subjects in a head-elevated prone group compared to 48 subjects in a supine-positioned group, $P = 0.002$) but different positional care had no significant effects in cumulative number of subjects with normal respiratory rate within two hours (39 subjects in a head-elevated prone group compared to 30 subjects in a supine-positioned group, $P = 0.234$) as shown in **Table 3**.

The body temperature of subjects at aged 30 minutes, one hour and two hours in labor room are shown in **Table 4** and the subjects in both groups had normothermia (body temperature 36.5 - 37.5°C)

Comparing of the optimum infant body temperature range (37.0 ± 0.2°C) at aged 30 minutes, one hour and two hours between the two groups, we found that subjects in a head-elevated prone group had significantly more optimum body temperature range especially at aged two hours in labor room (88 subjects in a head-elevated prone group compared to 75 subjects in a supine-positioned group, $P = 0.02$) as shown in **Table 5**.



RR ; respiratory rate, BT ; body temperature, CBG ; capillary blood glucose, Hct ; hematocrit, LR ; labor room

Figure 1. Flow chart of this study.

Table 1. Baseline characteristics of the subjects.

Baseline characteristics	Head-elevated prone (n = 100)	Supine-positioned (n = 100)	*P*-value
Gestational age* (weeks)	38.8 ± 1.0	38.7 ± 1.1	0.3
Birth weight* (g)	3,165.0 ± 41.8	3,086.0 ± 433.9	0.01
Male, n	52	54	0.9
Route of delivery, n			0.1
Vaginal delivery	55	66	
Cesarean section	45	34	
Apgar at 1 min^{+} (IQR)	8 (1)	8 (1)	0.2
Apgar at 5 min^{+} (IQR)	10 (0)	10 (0)	0.3
Apgar at 10 min^{+} (IQR)	10 (0)	10 (0)	0.1
Maternal risks, n			
DM	6	14	0.1
SGA	3	4	-
Hypertension	2	5	0.4
MSAF	26	10	0.01
Fetal distress	10	3	0.1
Previous cesarean section	21	27	0.4
Other risk**	37	30	0.4
Onset of rapid shallow breathing* (mins)	41.1 ± 17.4	43.5 ± 26.1	0.6

*Mean ± SD, ** Teenage pregnancy, Elderly gravida, $^{+}$Median (IQR)
DM; Diabetes Mellitus, SGA; small for gestational age, MSAF; meconium stained amniotic fluid

Table 2. The subject's tachypnic characteristics.

Data	Head-elevated prone (n = 100)	Supine-positioned (n =100)	*P*-value
Treatment after 2 hours aged			0.88
Stayed with mother	46	48	
Admitted	54	52	
Investigation			0.03
CBG, Hct	62	46	
Full investigations**	38	54	
Definite diagnosis			0.005
Adaptation	38	30	
Delayed adaptation	31	16	
TTN	31	52	
MAS (mild)	0	2	
Duration of tachypnea (mins)*	340.4 ± 356.1	685.5 ± 780.0	0.0004

* Mean ± SD, ** CBG, Hct, complete blood count, hemoculture, chest x-ray
TTN; transient tachypnea of the newborn, MAS; meconium aspiration syndrome
CBG; capillary blood glucose, Hct; hematocrit

Table 3. Cumulative number of subjects with normal respiratory rate in certain periods.

Duration used to normal RR (RR≤ 60/min)	Cumulative number of head-elevatedprone subjects	Cumulative number of supine-positioned subjects	*P* - value
Normal RR within 2 hours	39	30	0.234
Normal RR within 4 hours	63	44	0.010
Normal RR within 6 hours	70	48	0.002

Table 4. The body temperature of subjects at aged 30 min, 1 hour and 2 hours in labor room.

BT(˚C)	Head - elevated prone (Mean ± SD)	Supine -positioned (Mean ± SD)	*P* - value
BT at aged 30 min	37.1 ± 0.2	37.0 ± 0.2	0.06
BT at aged 1 hour	37.0 ± 0.1	36.9 ± 0.1	0.02
BT at aged 2 hours	37.0 ± 0.1	37.0 ± 0.2	0.14

BT: body temperature, ˚C: degree celsius

Table 5. The optimum infant body temperature at 30 minutes, 1 hour and 2 hours.

Optimum BT (BT in range 37.0 ± 0.2˚C)	Head elevated prone (n = 100)	Supine (n = 100)	*P* - value
Optimum BT at aged 30 min	65	69	0.65
Optimum BT at aged 1 hour	87	86	0.83
Optimum BT at aged 2 hours	88	75	0.02

Discussion

In this study the duration infants used to adjust their respiratory rate ≤ 60 breaths per minute in a head-elevated prone group is significantly shorter than a supine- positioned group (340.4 minutes *vs* 685.5 minutes, $P = 0.0004$), this result supported many literatures which reported that prone-positioned care is more beneficial in decreasing respiratory rate than supine positioned care. Our study is the first randomized controlled trial studied in term stable neonates within the transitional period. The study by Sharma P, *et al*.[21] is another randomized controlled trial studied the benefits of prone-positioned care in decreasing respiratory rate of 60 subjects which were infants less than 12 months of age admitted due to the diseases which had tachypnea as associated symptoms, and they were not in neonatal transitional period. Sharma P, *et al.* demonstrated that prone-positioned care group had substantially decreased respiratory rate compared to supine-positioned group, therefore there are at least 2 randomized controlled studies which confirmed the benefits of prone-positioned care in decreasing respiratory rate. However, we found that head- elevated prone care considerably normalized respiratory rate in 4 - 6 hours after birth, but no significant effect within two hours, thus if there were a transitional nursery caring and supporting infant's transitional adaptation in Sirindhorn Hospital, the infant should be taken care in the head elevated prone position at least 4 hours in order to normalize respiratory rate and increase the number of infants be able to stay with their mothers at postpartum ward.

This study is the first randomized controlled research depicted the benefits of prone positioned care and optimum temperature range in term neonatal transitional period. Ammari A, *et al.*[22] published the randomized controlled trial studied benefits of prone positioned care and thermoregulation in 32 subjects. All subjects were preterm which adjusted post menstrual age of 33 - 38 weeks and they were not in transitional period. Ammari A, *et al.* demonstrated the prone position could significantly decrease the metabolic rate, heat production and a change of body temperature to environment.

Concerning for SIDS in prone position, we proposed guideline for prevention. Infant's head was

elevated in prone position with face tilted, then nurse can clearly see the infant's alar nasi and lips color. The nurse to infant ratio was 1 : 1. Oxygen saturation was continuously monitored. Respiratory rate, work of breathing and body temperature was closely observed and recorded every 30 minutes to 1 hour. If during an observation, infants had worsened work of breathing, desaturation, labile hypoxemia or apnea, the nurse would promptly give positive pressure ventilation and notify pediatrician. In this study, there were no subject who had worsened work of breathing, labile hypoxemia, PPHN, apnea or SIDS. This prevention guideline can be adapted to use in transitional nursery during prone position care.

The study is a single-center study which has been completed in Sirindhorn Hospital therefore, the results of the study can be applied to nine hospitals of Bangkok metropolitan administration which have the same context, also this is not a blinded study which may have selective bias

Although our study supported the benefit of prone position care in stable tachypnea but the study was performed in hospital setting with continuously oxygen saturation and respiratory monitoring, this result may not be applied in other setting such as home.

Conclusion

Head-elevated prone position care for stable term neonate with tachypnea in transitional period can significantly decrease infants' respiratory rate within four hours compared to supine-positioned care.

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Conflicts of interest statement

The author had completed an ICMJE disclosure form. No any potential or actual relationship, activity or interest were related to the content of this article.

Data sharing statement

This present review is based on the references cited. Further details, opinions and interpretation are available from the corresponding authors on reasonable request.

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