Learning Package

(LP:18:01)

Neonatal Thermoregulation

Sites where Learning package applies	All sites who provide care for neonates under 29 days old
Description	This package is an education program which will allow nurses to provide timely and expert care for neonates within Hunter New England Local Health District (HNE LHD)
Target audience	Nurses required to provide care for neonates in Neonatal Intensive Care Unit (NICU) or Special Care Nursery (SCN) settings
Learning Outcomes, On completion of this package you will be better able to:	1. Understand the neonatal thermoregulation physiology required to safely and efficiently care for the neonatal patient. 2. Understand appropriate interventions required to maintain normothermia.

Keywords	Neonatal, thermoregulation, cold stress, hypothermia, hyperthermia
Document registration number	LP:18:01
Replaces existing document?	Yes

Related Legislation, Australian Standard, NSW Ministry of Health Policy Directive or Guideline, National Safety and Quality Health Service Standard (NSQHSS) and/or other, HNE Health Document, Professional Guideline, Code of Practice or Ethics:

'Thermoregulation of the neonate in NICU' (NICU_JHCH_04.02)
http://intranet.hne.health.nsw.gov.au/__data/assets/pdf_file/0010/139618/ThermoregulationJuly2015.pdf

- See recommended reading / reference list on page 6

Is this package recorded in MHL?	Neonatal: Thermoregulation (180462595)
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Neonatal Thermoregulation

Learning Package

2017

NSW GOVERNMENT Health
Hunter New England
Local Health District

Learning Package Overview

Purpose: This learning package provides the theoretical underpinning required before a registered nurse can safely manage thermoregulation for the neonatal patient.

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Introduction

Thermoregulation provides a consistent challenge in neonatal care. Nurses caring for infants need to have knowledge of, and understand the principles of, thermoregulation. Nurses also need to possess skills in order to provide appropriate management of temperature control in the clinical environment.

Disclaimer

This learning package has been prepared by health professionals employed in Hunter New England Local Health District in the Neonatal Intensive Care Unit at John Hunter Children's Hospital. While all care has been taken to ensure that the information is accurate at the time of development, the authors recommend that all information is thoroughly checked before use if utilised by another unit, context or organisation.

Aim

To provide beginning RN's with the knowledge and understanding of thermoregulation physiology and principles, and the important role that temperature maintenance plays in the infant's care.

Learning Outcomes or Learning Objectives

Throughout the LP there are readings and activities that you will need to complete. Readings can be accessed on-line through CIAP. When complete return the package to a nurse educator who will review and discuss it with you.

Completion of this package will attract 2 Continuing Professional Development (CPD) points which are a requirement for national registration and a certificate can be issued to you for your portfolio.

At the completion of the program it is expected that the RN will be able to:

- Discuss the mechanisms of heat loss & gain
- Describe how thermal management is applied in the clinical setting of the NICU or SCN
- Provide relevant information to parents with infants in the NICU / SCN on thermoregulation and its management.

Pre-requisites

In order to complete this education package the registered nurse must have met the following requirement:

- Are currently working in a SCN or area where neonatal thermoregulation knowledge and skills form part of current practice

Learning Package Outline

The package is designed to be a self-directed learning experience that will guide you through the literature and clinical issues related to neonatal thermoregulation.

This package is developed within an adult learning framework so not all activities need to be documented but it is expected that you will complete them in order to facilitate your learning.

Problem based learning

This program is based on a problem-based approach to learning. This approach has been chosen to enhance critical thinking, and to create a body of knowledge that the RN can apply to practice. Problem based learning (PBL) is characterised by the use of patient specific problems or situations as a context for developing problem-solving skills and for acquiring clinical knowledge.

How to use this resource or Instructions for participants

- It is expected that this SDLP will require approx. 2 hours to complete. If you experience difficulty, please discuss this with your nurse educator.
- Completion of this package is equivalent to 2 Continuing Professional Development (CPD) hours which is a requirement for National Registration. Evidence of CPD can be generated using the 'Reflection on Learning' page at the end of the package.
- This package can be used as an introduction for nurses wishing to further their knowledge and skills in the area of neonatal thermoregulation and its management.
- At the completion of this learning package you are asked to complete questions or a problem based scenario related to the topic.
- There is a suggested reference list and it is by no means complete. Please read widely to facilitate your learning.
- This resource has been written from a Hunter New England Area Local Health District perspective so it is not specific to any one health facility. Throughout the package procedures from the John Hunter Hospital may have been mentioned as an example of practice only.
- Through out this self directed learning package there are readings and activities that you will need to complete. You can access the readings online (journal articles) through CIAP. The

online readings are not provided within this document due to copyright law restrictions. You will be provided with information on how to access the online readings. If you have any difficulty locating the readings please seek assistance from your hospital / health facility library.

Understanding of legal issues, accountability and professional responsibilities of practice

Hypothermia is common in infants born at hospitals and homes, even in tropical environments. Although hypothermia is rarely a direct cause of death, it contributes to a substantial proportion of neonatal mortality globally, mostly as a comorbidity of severe neonatal infections, preterm birth, and asphyxia. (Lunze et al, 2013)

It is also important to review the NICU JHCH guideline called 'Thermoregulation of the neonate in NICU' (NICU_JHCH_04.02)

http://intranet.hne.health.nsw.gov.au/__data/assets/pdf_file/0010/139618/ThermoregulationJuly2015.pdf which discusses evidence-based practice surrounding thermoregulation principles.

Health/safety and risk management

This is a responsibility for all staff and includes knowledge of procedures relating to:

- Using and transporting thermoregulatory equipment
- Ensuring safety at all times when opening incubator doors or taking the whole side down for moving the infant from the incubator.
- Ensuring parents are aware of safety features of incubator.
- Taking care when moving incubator, this must be done with two staff.
- Incubators should be changed every seven days to minimise the risk of infection.
- Incubators should be wiped over each shift especially along the portholes.
- Use of personal protective equipment (PPE)
- IIMS reporting of errors or incidences

Infection prevention & control standards

You should become familiar with the HNELHD infection prevention and control standards that are available through HNELHD intranet site and PPG. Some specific risks associated with thermoregulation management are :

- Ensuring that incubators are changed every 7 days to minimise the risk of infection.
- Ensuring that incubators are wiped over each shift, especially along the portholes, with neutral detergent.

Recommended Readings

- Altimier, Leslie. (2012) Thermoregulation: What's New? What's Not? *Newborn & Infant Nursing Reviews,*12 (1), 51-63

- Bissinger, R & Annibale, D (2010) Thermoregulation in Very Low- Birth-Weight Infants during the Golden Hour. *Advances in Neonatal Care,* 10 (5), 230-238.

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- Chang HY, Sung YH, Wang SM, Lung HL, Chang JH, et al. (2015) Short- and Long-Term Outcomes in Very Low Birth Weight Infants with Admission Hypothermia. *PLOS ONE* 10(7)

- Hillman, N H.,Kallapur,S G. & Jobe, A H. (2012) Physiology of Transition from Intrauterine to Extrauterine Life. *Clinical Perinatology,* 39, 769-786

- Jia,Y; Lin,Z; Lv,H, Li,Y, Green,R and Lin,J. 2013. Effect of delivery room temperature on the admission temperature of premature infants: a randomised controlled trial. *Journal of Perinatology* 33 (4)

- Knobel-Dail,R (2014) Role of Effective Thermoregulation in Premature Neonates. *Research and Reports in Neonatology* , 4.

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- Lambeth,T; Rojas,M; Holmes,A and Dail,R. (2016) First Golden Hour of Life : A Quality Improvement Initiative. *Advances in Neonatal Care* 16(4)

- Lunze,K; Bloom,D; Jamison,D and Hamer,D. (2013) The Global Burden of Neonatal Hypothermia : A Systematic Review of a major challenge for Newborn Survival. *BMC Medicine* 11 (24)

- Manani,M; Jegatheesan,P; DeSandre,G; Song,D; Showalter,L and Govindaswami,B. (2013) Elimination of Admission Hypothermia in Preterm Very Low-Birth-Weight Infants by Standardisation of Delivery Room Management. *Permanente Journal* 17(3)

- Oatley,H; Blencowe,H; and Lawn,J. (2016) The effect of coverings,including plastic bags and wraps, on mortality and morbidity in preterm and full term neonates. *Journal of Perinatology* 36 (1)

- Reuter,S; Messier,S and Steven,D. (2014) The neonatal golden hour – intervention to improve quality of care of the extremely low birth weight infant. *SD Med* 67(10)

- Russo,A; McCready,M; Torres,L; Theuriere,C; Venturini,S; Spaight,M; Hemway,R; Handrinos,S; Perlmutter,D; Huynh,T; Grunebaum,A and PerlmanJ. (2014) Reducing hypothermia in preterm infants following delivery. *Pediatrics*. Vol133(4)

Reflection tool
At the completion of the Learning Package we have added a reflection form that will assist you in reflecting on the package and how it meets your professional development needs. This is kept in your Professional Portfolio.

Evaluation
We have also added a Learning Package Evaluation form for completion by staff members who complete the package.

Thermoregulation is the balancing of heat production and heat loss with the intention of maintaining body temperature within an accepted range.

An infant does not maintain temperature independently prior to delivery. Foetal body temperature is approximately 0.5˚C above the maternal temperature in utero (Hillman et al, 2012).This foetal/maternal temperature relationship results from a combination of endogenous heat production by the foetus and the surrounding core temperature of the mother (Bissinger & Annibale, 2010).

At birth, heat is rapidly lost due to the cold external environment and significant evaporative heat. The infant's temperature may also increase due to excessive environmental temperatures, sepsis or changes in the hypothalamic control mechanism secondary to birth trauma.

Evidence continues to link hypothermia after birth with neonatal morbidity and mortality. A study conducted in 2007 examined 5,277 infants born between 2002 - 2003 weighing 401–1,499 g. Hypothermia was prevalent in this group, with 14.3% of the infants having an admission temperature less than 35°C and 32.6% having a temperature between 35°C and 35.9°C. These researchers (Laptook et al, 2007) found that admission temperature was inversely related to mortality, with a 28% increase in death for every 1°C decrease in temperature, and with late-onset sepsis, with an 11% increase in sepsis for every 1°C decrease in temperature. (Knobel-Dail, 2014)

Healthy term infants are able to self-regulate by producing or losing heat. Premature, low birth weight or sick infants are vulnerable to temperature instability because of their diminished capacity for metabolic heat production.
These infants are nursed in a neutral thermal environment to reduce the risk of cold stress so that minimal energy is spent, thereby minimising oxygen and energy consumption.

A thermal neutral environment is the environment in which an infant is able to maintain a normal body temperature by using vasomotor control and changes in posture, with minimal energy consumption. The appropriate environmental temperature is directly related to an infant's ability to maintain a stable body temperature (Altimier, 2012). The following characteristics put newborns at a greater risk of heat loss:

- A large surface area-to-body mass ratio
- Decreased subcutaneous fat
- Greater body water content
- Immature skin leading to increased evaporative water and heat losses
- Poorly developed metabolic mechanism for responding to thermal stress (e.g. no shivering)
- Altered skin blood-flow (e.g. peripheral cyanosis)

Hypothermia occurs when the newborn's axillary temperature drops below 36.3°C (ACoRN, 2012)

JHCH NICU CPG uses the WHO 1997 definition of temperature range to define normal and abnormal temperatures.

Temperature ranges (WHO, 1997)

- >37.5ºC - Hyperthermia
- 36.5-37.5ºC – ***Normal range***
- 36.0-36.5ºC - Mild hypothermia (potential cold stress)
- 32.0-36.0ºC - Moderate hypothermia
- <32.0ºC - Severe hypothermia

Reading 1:

- Bissinger, R & Annibale, D (2010).Thermoregulation in Very Low- Birth-Weight Infants during the Golden Hour. *Advances in Neonatal Care,* 10 (5), 230-238.

Activity 1:

- Discuss the definition of thermoregulation with your preceptor or educator and outline below.

Activity 2:

- Identify infants who are at risk of temperature instability and discuss why they are at risk.

Heat Production

Newborn infants are able to produce heat through;

- **Alterations of body position:** heat is produced from glycogenolysis and glucose oxidation by increased motor activity and voluntary muscle tone
- **Vasoconstriction:** results in a reduction of warm blood flow to the peripheries by vasoconstriction in the deep dermal arterioles
- **Non-shivering thermogenesis:** is associated with lipolysis in brown adipose tissue and is the primary source of heat production in neonates (Knobel-Dail, 2014).

Brown adipose tissue production begins at 28 weeks gestation, and continues to be produced until 3 to 5 weeks post-delivery. Brown fat is predominantly located around the scapulae, the clavicle line, in the axilla, along the spinal cord and also around the kidneys and adrenals (Altimier, 2012).

Distribution of neonatal brown fat stores

Preterm infants have limited ability to initiate non-shivering thermogenesis as they have reduced stores of brown adipose tissue (Altimier, 2012).Brown adipose tissue is restricted by two factors:

- Quantity- it cannot be replenished.
- Hypoxia- leads to impairment of the metabolism of brown fat.

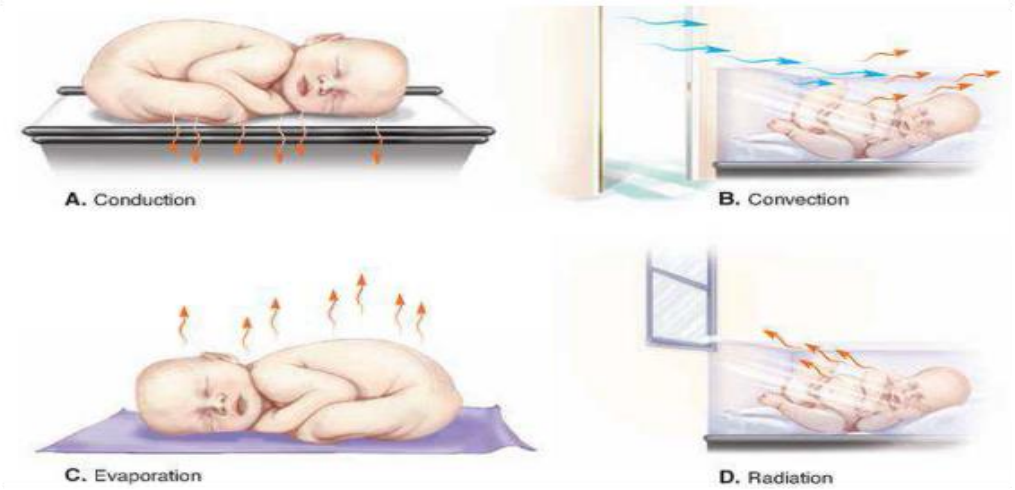
Heat loss and gain

The four modes of heat loss or gain are convection, conduction, evaporation and radiation. When assessing an infant's thermal environment, it is essential to account for all sources of heat gain or loss. Heat always transfers from a higher to a lower temperature.

Four Mechanisms of heat loss to the environment:

- **Convection:** The transfer of heat between areas that are in contact with each other but that are not solid. Heat loss occurs as cool air/liquid move over an infant. Heat gain occurs when the infant is in an area where the circulating air/liquid is of a greater temperature than the infant.
- **Conduction:** Heat loss or gain by transfer of heat between two solid objects through surface to surface contact eg: cold x-ray plate.
- **Evaporation:** Loss or gaining of body heat associated with moisture concentration differential among skin, respiratory tract and air.
- **Radiation:** The transfer of heat/coolness between solid surfaces where there is no direct contact (Altimier, 2012)

Figure 1: The four mechanisms of heat loss to the environment. Ricci,S. Kyle, T (2006)



Reading 2:

Altimier,L. (2012) Thermoregulation: What's New? What's Not? *Newborn & Infant Nursing Reviews,*12 (1)

Activity 2:

a) Outline why the neonate is particularly vulnerable to temperature instability following birth?

b) Can you think of ways infants may lose heat via conduction, convection evaporation or radiation in the NICU? Give an example for each.

c) Identify strategies that may assist in reducing heat loss from these mechanisms.

Thermal Management

Thermal management of the infant includes the measures taken at birth and in the early days of life to ensure the infant does not become either hypothermic or hyperthermic. Body temperature regulation relies on sub motor and vasomotor activity, modifications of heat production and alterations in motor tone and activity. An infant's temperature is managed within an accepted range. This range needs to be broad enough to allow for fluctuations that occur during activity and during sleep.

	Hypothermia (Cold Stress)	Hyperthermia (Heat Stress)
Gastrointestinal	Abdominal distension, vomiting	Poor feeding
Cardiac	Bradycardia	Tachycardia, flushed skin
Respiratory	Shallow irregular breathing, grunting, decreased respiratory rate, acidosis, hypoxia	Tachypnoea
Neurologic	Restlessness	Irritability, hypotonia, lethargy, brain damage, death

Hypothermia :
Is defined as "the state in which an individual's body temperature is reduced below normal range". The World Health Organisation (1997) and the American Academy of Paediatrics advocate normal temperature range to be between 36.5C - 37.5C per axilla.

Hypothermia of an infant imposes significant effects such as decreased surfactant production, increased oxygen consumption and the depletion of calorie reserves. If the increased oxygen demand is unable to be met by the cardio-respiratory system, then hypoxia occurs, resulting in anaerobic metabolism and acidosis. The metabolic response of an increase in heat production is met by glucose and fat metabolism. The increase in glucose metabolism may lead to hypoglycaemia, while fat metabolism contributes to acidosis. Signs and symptoms that may indicate the presence of hypothermia include tachypnoea, body cool to touch, acrocyanosis, central cyanosis, poor feeding, bradycardia, hypoglycaemia and lethargy.

Consequences of hypothermia in the newborn
Treating hypothermia in the newborn is important in order to avoid serious and potentially life-threatening complications. Increased cellular metabolism takes place as the newborn tries to stay warm, leading to increased oxygen consumption, which puts the newborn at risk of hypoxia, cardiorespiratory complications, and acidosis. These newborns are also at risk for hypoglycaemia because of the increased glucose consumption necessary for heat production. Neurological complications, hyperbilirubinemia, clotting disorders, and even death may result if the untreated hypothermia progresses.

Hyperthermia
An infant's large surface area, limited insulation and ability to sweat may predispose him to overheating. Hyperthermia may be due to a response to inflammation or infection, or, due to over wrapping or an overly warm environment.

Consequences of hyperthermia in the newborn
Hyperthermia develops rapidly in neonates, causing increased oxygen consumption and an increase in metabolic rate. Signs and symptoms of hyperthermia include tachypnoea, tachycardia, hypotension, lethargy and skin temperature greater than core temperature.

Interventions

Thermoregulatory devices and management

The primary goal of devices for thermal management is to maintain a stable temperature, for optimised growth and development of an infant. There are various methods of thermal management available and over the past few years a number of Cochrane reviews (see reference list) have been undertaken to review and summarise the evidence for the available methods.

Delivery room temperature

The World Health Organisation recommends delivery room temperatures of approx. 25°C. Studies have shown that admission rectal temperatures of <32 week newborns were significantly improved where the birth room temperature was set from 24-26 °C. (Jia et al, 2013)

Regular temperature monitoring is an integral part of thermal management.

Methods of temperature assessment currently practiced in this nursery include axillary and skin temperature monitoring. The frequency of these observations is dependent on the stability of the infant.

Open Care Centre or radiant warmer:

Heat is generated from an infrared heating element positioned over an open bed. Radiant warmer beds may be controlled manually or by servo control (maintenance of temperature at a set point via a skin probe positioned on the infant). This method of heating reduces radiation heat loss from an infant. However, evaporative and convective heat loss in increased as the infant is exposed to cooler room currents

Isolette:

Isolettes, incubators or cribs are designed to reduce heat loss. They are fully enclosed, they may be single or double plexiglass walled (double walled reduces heat loss through radiation). The isolette is heated with convective heat and offers the ability to produce a micro environment for the infant. The goal is to prevent heat loss from the infant and ensure a relatively stable air temperature (Altimier, 2012) Isolettes can also be humidified for those infants requiring ambient humidity.

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Giraffe OmniBed ®:

Combines features of a radiant warmer, isolette and humidified system in one device. It also provides access to the infant for procedures, without physical movement of the baby.

Kangaroo Care:

Skin to skin contact is an effective method of maintaining adequate central temperature. This widely endorsed practice also has the benefit of increasing parental involvement and decreasing maternal anxiety.

Plastic Wrap:

Plastic covering the torso and extremities of neonates is recognised as a low-cost means to prevent hypothermia by reducing both conductive and evaporative heat loss. A recent Cochrane Review of interventions to prevent hypothermia in preterm neonates suggested that plastic bags reduced heat losses by 0.7 °C in neonates <28 weeks, with a 44% reduction in hypothermia observed. (Oatley et al, 2016)

Hats / beanies:

The theory behind applying a hat or beanie is centered on reducing thermal loss from the largest surface area in the neonate. Evidence is limited, but a study conducted in 2003 by Lang showed that woolen hats provided more thermal benefit when compared to cotton stockinette hats in term babies. There are no RCT's that have been conducted in preterm babies.

Reading 4:

- Altimier, L. (2012) Thermoregulation: What's New? What's Not? *Newborn & Infant Nursing Reviews,*12 (1), 51-63

Activity 4:

a) Name the thermoregulatory devices available in your nursery and describe their use.

b) Which infants are placed in a humidified isolette? Discuss the rationale for nursing the infant in a humidified environment.

c) Where would you place a temperature probe? Why?

Clinical scenarios:

1. **Brett was born at 32 weeks gestation weighing 1540g. He had a Kangaroo cuddle with mum in delivery suite prior to his admission to Special Care Nursery. On admission what observations do you record and why?**

- What is the rationale for placing Brett into an isolette?

- What isolette setting should be used?

- If Brett's temperature was 38°C, outline what other observations you would make and what symptoms you would expect to see.

2. **You are also caring for Cooper who was born at 24 week gestation; he is now eight weeks old at 32 weeks corrected gestation. His temperature is 36.6°C in an isolette temperature of 31°C. What other factors do we take into consideration before 'weaning' Cooper from the isolette?**

- Refer to the policy and describe how you would wean Cooper from the isolette.

- Cooper is now nursed in an open cot. Why is it important to observe his temperature and how often should this be done?

- Cooper's temperature is 36°C. What action would you take?

Conclusion

The challenge for nurses working in a neonatal care is to understand thermoregulation, the consequences of cold and heat stress, so that they may provide an appropriate thermal environment, prevent the complications of cold or heat stress and promote the normal growth and development for the infants in their care.

You should familiarise yourself with other policies and procedures in your organisation which relate to thermoregulation, as they will assist you in your nursing care of these infants.

Learning Package: Reflection on Learning

This document guides your reflection on the extent to which the package meets your professional development needs, and how you plan to apply your learning into practice. This tool is not part of the assessment process, and has been included as a document that you may wish to include in your professional portfolio. Time taken to complete learning package: _____

What was your purpose in completing this learning package?

_____

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Did you achieve this by completing the learning package?

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Reflecting on the content, what key learning have you obtained?

_____

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What learning will you apply to your practice immediately? How will you do this?

_____

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What learning needs have you identified as a result of completing this learning package?

_____

_____

_____

How do you plan to address these needs?

_____

_____

Signature:_____Date:_____

Learning Package Evaluation Form

Your feedback regarding this learning package is important to ensure the package meets your learning needs. Please take 5 minutes to answer the following questions to facilitate any change required for future learning packages.

1. The learning outcomes of the learning package were clearly identified — Yes / No

2. The learning outcomes of the package were appropriate

3. The content provided enabled me to meet the learning outcomes? — Yes / No

4.The activities motivated my interest in the topic — Yes / No

5.The activities and workbook questions supported my understanding of the topic

6.The package was presented in a logical manner — Yes / No

7.The assessment process related to this package was clearly outlined (if applicable) — Yes / No

8. My most relevant learning outcomes from this package were:

_____

_____

9. The key learning points from this package I can immediately apply to practice include::

_____

_____

10. The least relevant component(s) of this package were:

_____

_____

11 Some suggestions I would like made to improve the package would be:

_____

_____

12. Further comments:

_____

_____

Thank you for your time.

Return to:
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