

# *Physics of Medical Devices*

*Fifth lecture*

## *Infant Incubator*

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## **Infant Incubator**

Infant incubator is a Bio Medical Device which provides Warmth, Humidity and Oxygen all in a controlled environment as required by the New born.

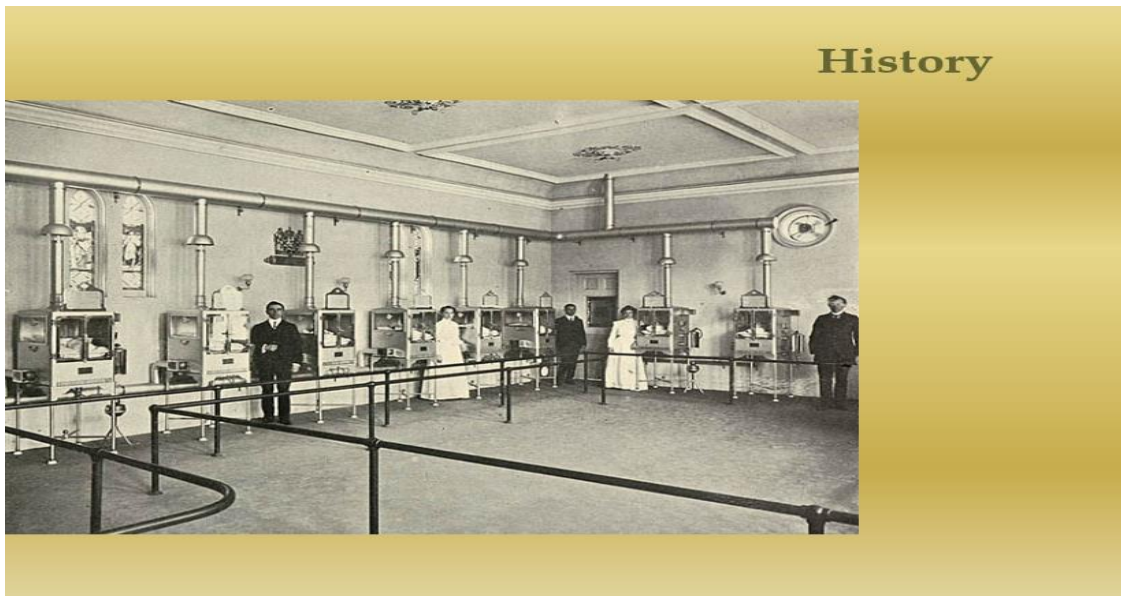
### **History**

In 1891 - First modern Incubator invented by Dr.Alexander Lyon.

1898 - First American Incubator Hospital was set up at the Trans Mississippi Exposition in Omaha , Nebraska.

1907 - Pierre Constant Budin released the study of Influence of Body temperature on Infant Mortality.

In 1932 - Julius Hess in his patents for incubators proposed a mechanism for the addition of supplemental oxygen in the Incubator.



## **Physical principles of work**

The infant incubator is normally in the form of a trolley with a small mattress on the top covered by a rigid clear plastic cover.

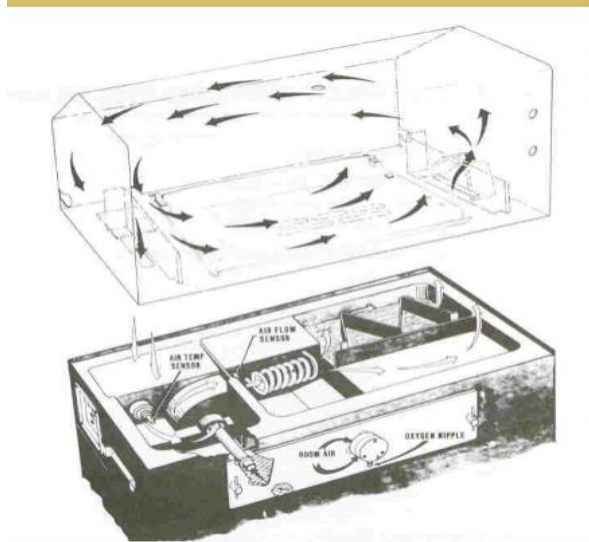
Incubator chamber provides a clean environment, and helps to protect the baby from noise, dust, infection, and excess handling.

A temperature sensor is taped to the baby's skin, and the incubator heater adjusts to maintain the baby at a constant temperature or, the temperature is controlled by a thermostat in the heated air stream.

Underneath the baby is an air-blown electric heating system and humidification system which circulates heated humid air at a desired temperature and humidity through the incubator chamber.

Additional oxygen may also be introduced into the chamber.

### Principle



## **Important Parameters**

- ❖ Temperature
- ❖ Humidity

## **proportional temperature controller**

## **Body Temperature**

- ✓ Normal core body temperature can range between 98.9 F and 99.9 F .
- ✓ Cells, tissues and organs operate efficiently only within this narrow temperature limits .
- ✓ If the temperature rises 2°F above the normal of 98.6°F, we become ill. If it rises 7°F, we become critically ill.
- ✓ If our temperature decreases 2°F, we feel cold. A 7°F decrease puts our life in jeopardy

## **Body Temperatures**

- + Hypothermia Low body temperature is called Hypothermia
- + Hyperthermia High body temperature is called Hyperthermia

## **Hyperthermia**

## **Hyperthermia in Neonates can lead to**

- ☒ Increased oxygen requirements
- ☒ Apnea
- ☒ Dehydration
- ☒ Metabolic acidosis

- ☒ Heat stroke, brain damage, shock and even death.

## **Thermoregulation**

Thermo regulation is the ability of the body to balance the heat produced in the body with the heat lost by the body thereby maintaining the body temperature in the normal range.

- ❖ The temperature of the body is regulated by hypothalamus
- ❖ Sweating begins almost precisely at a skin temperature of 37°C
- ❖ If the skin temperature drops below 37°C, a variety of responses are initiated to conserve the heat in the body and to increase heat production

## **Heat Production**

Due to metabolic activities

## **Heat Loss**

- ❖ Evaporation
- ❖ Conduction
- ❖ Convection
- ❖ Radiation

## Evaporation

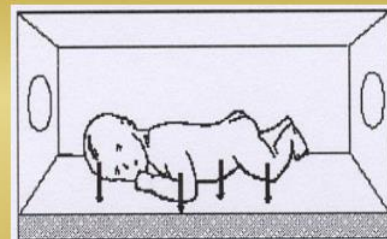
Heat loss due to water evaporation from skin and respiratory tracts



Evaporation

## Conduction

Heat loss to cool the surrounding air.



Conduction

## Convection

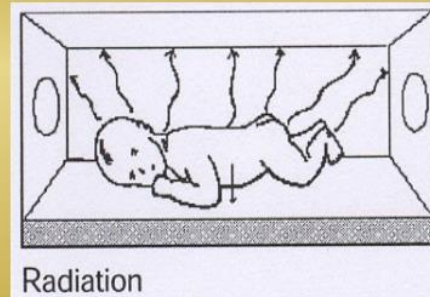
Heat loss to cool solid objects which are in direct physical contact.



Convection

## Radiation

Heat loss to cool solid objects which are not in direct physical contact.



### Neonatal Risk

- Have limited thermoregulatory ability
- Transition from the Poikilothermic to Homeothermic state is delayed.
- Rely on external heat to maintain their core temperature
- Thermal instability can last for several days or even weeks!

### Application

- ❖ NICU
- ❖ SCN
- ❖ Post natal care wards
- ❖ Transport Incubators can be found in Labour ward to transport the new born to Post natal wards or NICU.
- ❖ Hospitals that don't have a dedicated NICU will have a transport incubator so that critical new born can be shifted via ambulance or helicopters to the nearest hospital having an NICU facility.