Improved thermomanagement in neonatal care

How the innovative concept of the electronic double wall improves clinical outcomes and workflows in NICUs

Dräger

Technology for Life

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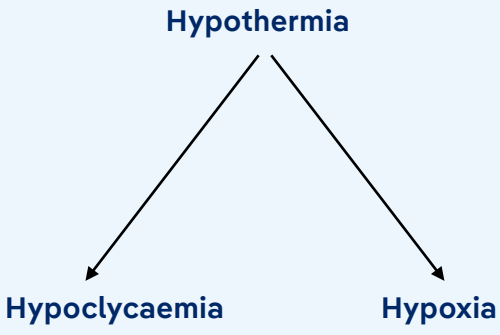
For premature infants, even a slight deviation in body temperature can have serious consequences: A body temperature of just one degree Celsius lower causes mortality to increase by nearly one-third[1]. For this reason, premature infants with low or very low birth weight require special attention in intensive care. As Your Specialist in Acute Care, we offer tailored solutions for the special needs of the most vulnerable of patients in your hospital. Our mission is to support you with state-of-the-art medical technology to help reduce infant morbidity and mortality rates, as well as reduce stress to both baby and clinical staff. With years of experience in neonatal care innovation, we have taken warming therapy to a new level with our electronic double wall invention.

> **Every newborn deserves a good start in life.**
>
> **Stefan Dräger,**
> **Chief Executive Officer, Dräger**

Why thermoregulation matters?

Thermoregulation is a basic, yet crucial practice, in particular for premature babies who cannot regulate their own body temperature. Routine nursing and surgical procedures can cause an alteration in the environmental temperature, thus creating thermal stress for infant patients. Thermal stress is correlated with a decline in body weight and affects metabolism, O_2 intake, and respiratory rate, and can ultimately lead to hypoglycaemia and hypoxia. [2,3]

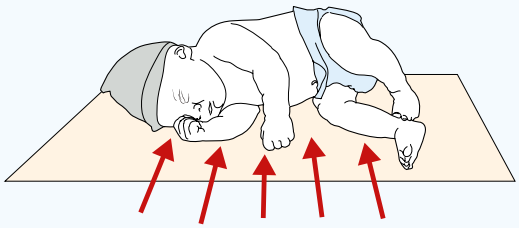


How Babyleo supports babies with a stable microclimate?

The goal of an infant incubator is to provide a controlled and stable microclimate with warm, humidified air that can be enriched with oxygen. To provide an optimal microclimate for premature or newborn infants, four ways of heat transfer must be considered during the development of an incubator: radiation, conduction, convection, and evaporation.

Heat transfer mechanisms

Conduction

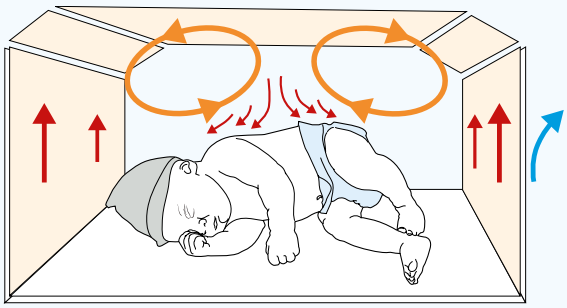


A heated mattress ensures an additional heat source, especially during the first week of the preterm infant's life

Evaporation

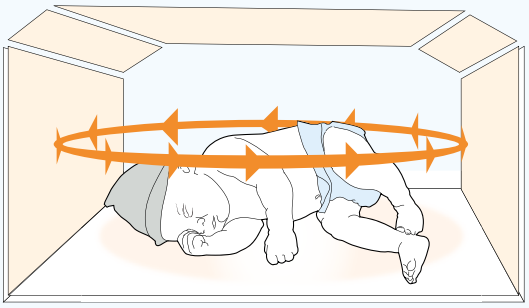
The goal is to avoid transepidermal water loss (TEWL) using up to 99% of relative humidity

Convection



A dual air curtain reduces convective heat loss, thus maintaining a "calm zone" for the baby with lower air speed

Radiation



Radiative heat loss is reduced with the electronic double wall "ClearView"

What can we offer to create and maintain a stable microclimate?

The traditional double wall concept

In an incubator, the controlled microclimate must be stable not only during the entire closed operation, but also when handports or side walls are opened to provide the infant patient with care. Therefore, the incubator must provide a stable airflow with low air velocity to the infant patient lying on the mattress. A technically simple way to ensure a stable airflow is to use side walls with doubled Plexiglas™, or so-called “double walls”. These double walls serve as air ducts to direct the warm, moisture-enriched air into the patient compartment. Even when the handports are open, the climate in the incubator remains stable. Since the double walls minimise the temperature gradient between the warm climate in the patient compartment and the cooler environment, condensation of high humidity inside the incubator is reduced.

The double wall concept and its benefits are many years old[4]. As early as the mid-1980s, Dräger manufactured the Incubator 8000, which already included a mechanical double wall. It had an innovative design with a removable double hood on the top. Together with a strong fan impeller, a double air curtain was created, so it became possible to achieve the same stable climate as with double conventional walls.

Our technological milestones in thermoregulation:

1987 Incubator 8000
First Dräger incubator including mechanical double wall on the front panel

2001 Caleo
Mechanical double wall on the hood. Elimination of mechanical double walls on the sides

Isolette family since 1990s
Mechanical double wall on the sides to prevent heating loss of the infant patient

2016 Babyleo TN500
Electronic double wall with ClearView function. Complete absence of mechanical double walls and on the hood

Electronic double wall with ClearView function

Dräger addressed the issue of stable incubator climate more intensively during the development of the IncuWarmer Babyleo TN500. This new innovative generation of warming therapy devices does not need a mechanical double wall, neither on the sides nor on the hood. With Babyleo, a new technology was implemented, the electronic double wall.

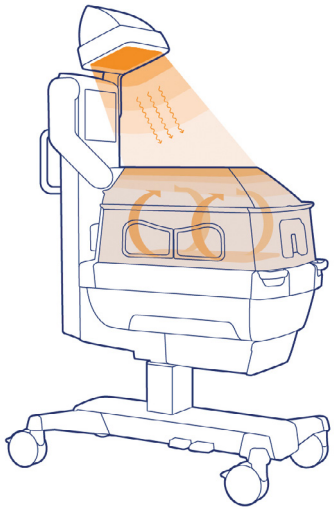
The electronic double wall allows the IncuWarmer to completely eliminate the need for mechanical double walls compared to other incubators. Its design suits optimal thermoregulation; Babyleo's three synchronised heat sources, consisting of convection, radiant warmer, and heated mattress, ensure optimal thermoregulation for the infant patient.

Due to the fact that the radiant heater is in a fixed position, it can be operated when the hood is closed. This reduces radiative heat loss from the infant patient to the walls and hood of the incubator. **So, it serves in the same way as mechanical double walls but uses radiant heater power instead of double Plexiglas™.**

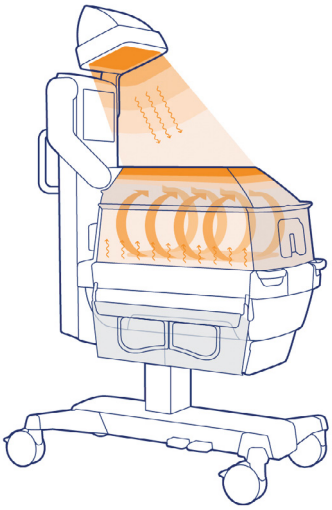
The radiant warmer also helps to reduce condensation on the incubator hood during operation. This allows for a better view of the infant patient, and as a result, with the electronic double wall comes the ClearView function. As a consequence, even when the humidity settings are high, condensation is significantly reduced on the incubator hood. With the ClearView function, clinical staff can have a better view of their patient.

To support hospital infection prevention protocols, the electronic double wall design makes it easy to clean and disassemble thanks to its limited number of parts.

In comparison, mechanical double walls have a disadvantage when it comes to infection prevention. Reprocessing the device represents significant additional effort and is time consuming, as the two walls on each side must be cleaned inside and out. Coupled with the locking mechanisms, which pose the risk of trapped debris, also results in difficulty when reprocessing and can lead to possible infection.



High humidity settings may cause the inside of the hood to fog up. To limit fogging, the ClearView function helps reduce condensation on the inside the hood and helps reduce radiative heat loss in the same way like mechanical double walls.



Babyleo with side walls open. When the side walls are opened, Babyleo automatically increases the dual air curtain which keeps the temperature in the patient compartment stable.

The relationship between body surface area and heat loss

Infant patients have a large body surface area in relation to their weight, which favors heat loss by radiation[5]. For this reason, it is very important to keep the largest areas of the newborn's body as warm as possible.

The largest surface areas are mainly front and back side but also the head of the patient.

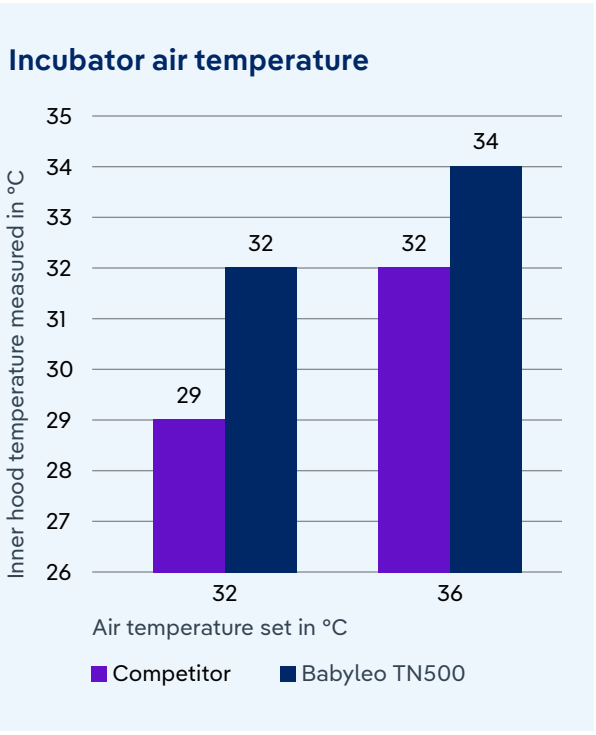
Since the back side of the patient is in contact with the mattress, it will receive heat transfer by conduction. A heated mattress helps to minimise heat loss due to conduction.

The front side of the patient needs to be protected from heat loss by radiation. In particular, the temperature in the hood plays an important role here. Additional heat supply from the radiant heater helps to warm the hood, thus minimising heat loss by radiation.

Positioning aids like nests not only support developmental care but also help to minimise heat loss by radiation and convection circulating inside the incubator. A hat placed on the infant patient's head reduces heat loss by convection and radiation.

A comparison between IncuWarmer Babyleo TN500 and a hybrid conventional incubator based on traditional mechanical double walls was performed, showing relevant results.

The goal of both the mechanical double wall and electronic double wall is to increase the temperature on the hood, thus limiting radiative heat losses when there is a drop in temperature. To evaluate the efficacy between each incubator designs, in a lab setting temperature sensors were placed on the inner side of the hood on both devices, Babyleo TN500 and the incubator with traditional mechanical double walls. Depending on the set air temperature in the incubator, the measured temperature inside the Babyleo hood when electronic double wall is used is up to 3°C higher compared to the mechanical double wall incubator. **This clearly demonstrates how Babyleo's electronic double wall and ClearView function is more effective in keeping the inner hood warmer and air temperature more stable in the incubator by reducing radiative heat losses.**



In Summary

Babyleo's electronic double wall with ClearView function benefits both clinical staff and infant patient in the following ways:

- Helps to reduce radiative heat loss to the inner walls of the hood better than a traditional mechanical double wall incubator, thus preventing thermal stress for the infant patient
- Optimises thermoregulation as it is more efficient in preventing radiative heat loss to the hood, which represents the largest surface area that can affect the infant patient
- Improves visibility to the baby by decreasing condensation at the inside of the hood
- Represents a substantial improvement in infection prevention and control compared to a conventional double wall incubator
- Facilitates reprocessing work for hospital staff, helping to optimise their workflows

References

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