THERMOMANAGEMENT FOR NEONATES
METHODS OF KEEPING NEONATES WARM

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Abstract: Especially preterm neonates needing external thermal support during their first days of life. Different warming concepts are used from convectional incubator, heated mattresses to open radiant warmers. Evaporative heat loss by the immature skin is a main effect which has to be taken into account by high humidity level in incubators. Too high surface temperature of the equipment as well as skin temperatures have to be avoided.

Keywords: Neonates, warming therapy, incubators, radiant warmers, hybrid

Introduction
Especially preterm neonates are not able to keep themselves warm without external thermal support. Equipment to keep neonates warm has been established for more than 110 years. There are several concepts in use on the market. In Europe convectional incubators are often used during the first days of life, whereas in North America infant radiant warmers are favoured. For more mature babies also heated mattresses are used, also in combination with other devices. Also so-called hybrids are used which combine different warming therapies (e.g., convectional incubator plus radiant warmer) and which allow the use of different “open” and “closed” therapies without moving the patient from one device to the other.

Warming therapy equipment
There are four different physical heat transfers available for the neonate:

a) One is the convectional heat transfer which allows a smooth warming effect but which is limited to a maximum air temperature of 39 °C [i]

b) Another main effect is the radiant heat transfer which is very effective but has to be limited [ii] to avoid injury. Without skin control by a skin temperature sensor the maximum radiant power is limited to 10 mW/cm² to avoid skin burns. The maximum skin temperature shall not exceed 39 °C. In incubators also the radiant heat can have a tremendous effect on immature babies; therefore often double wall incubators are used to reduce heat loss. In contrast underneath radiant warmers the convectional heat loss may play an important role because the radiant heat supplied to the mattress driving air flow around.

c) A further thermal effect is the conductive heat transfer mainly between mattress and skin. Often the mattress is from material (like foam) which is thermally insulating. However, also heated mattresses are used for caring mature babies alone or in combination with other heat sources. Because of the direct contact of the skin with the heater and the sensitivity of the skin the surface temperature has to be limited to 38 °C or 39 °C [iii].

d) Also, heat loss by evaporation (there is no heat gain) can be a main factor especially during the first week of life of premature babies because of the immature skin. Therefore the use of incubators with a high humidity level is recommended for the first days of life, whereas the use of infant radiant warmers increase the heat loss by evaporation in alignment with a higher water loss, which has to be balanced.

The advantages of incubators are the high humidity level in combination with a low air flow velocity and the option to increase the oxygen concentration within the compartment. However, access to the patient is limited by the hood. Therefore infant radiant warmers are often used when intense and repeated handling of the patient is required with the disadvantage of high evaporative heat loss and extreme temperature differences. Heated mattresses are often not able to supply sufficient heat for smaller babies alone without using other equipment.

Conclusions
Several warming therapy devices are in use to keep preterm neonates warm and have been optimized during the last decades. These devices are widely accepted by the user. No truly innovative concepts have been introduced other than hybrids which combine open and close warming therapy.

In September 2012 a group of international experts convened in a workshop organized by the DGBMT and discussed challenges and research opportunities in thermomanagement of neonates. The results from this workshop will be published in a VDE/DGBMT position paper.
Bibliography

1 IEC 60601-2-19 Medical Electrical Equipment: Particular requirements for safety and essential performance of baby incubators
2 IEC 60601-2-21 Medical Electrical Equipment: Particular requirements for safety and essential performance of infant radiant warmer
3 IEC 60601-2-35 Medical Electrical Equipment: Particular requirements for the basic safety and essential performance of heating devices using blankets, pads and mattresses and intended for heating in medical use