Bradycardia in Accidental Severe Hypothermia in a Newborn: Treat or Don't Touch? A case report

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Case report

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Abstract

Background

Hypothermia significantly affects mortality and morbidity of newborns. Literature about severe accidental hypothermia in neonates is limited. We present a case of a neonate suffering from severe accidental hypothermia. An understanding of the physiology of neonatal thermoregulation and hypothermia is important to decide on treatment.

Case presentation

We report a case of severe accidental hypothermia (rectal temperature 25.7°C) in a hypothropic newborn due to prolonged exposure to low ambient temperature. The newborn presented bradycardic, bradypneic, lethargic, pale and cold. Bradycardia, bradypnea and consciousness were interpreted in the context of the measured body temperature. Therefore, no reanimation or intubation was initiated. The newborn was closely monitored and successfully treated only with active and passive rewarming.

Conclusion

Clinical parameters such as heart frequency, blood pressure, respiration and consciousness must be interpreted in light of the measured body temperature. Medical treatment should be adapted to the clinical presentation. External rewarming can be a safe and effective measure in neonatal patients.

Background

Neonatal hypothermia is associated with significant mortality and morbidity. Available literature about severe hypothermia in newborns is limited. Therefore, case reports provide important information that is otherwise lacking. We present a case of a newborn with severe accidental hypothermia (rectal temperature of 25.7°C) due to prolonged exposure to low ambient temperature. We discuss the physiological findings and treatment of hypothermia, hyperglycemia, bradycardia and bradypnea in this newborn with accidental severe hypothermia.

Case Presentation

Case

A neonate with a gestational age of 36 to 38 weeks, weighing 2140g, was found at a disposal point in a cardboard box, nude, covered only with a blanket. The ambient air temperature was recorded as 1°C. The neonate was lethargic, but reacted to pain and opened her eyes.

She was breathing spontaneously without any signs of respiratory distress at a rate of 26 breaths per minute. Peripheral oxygen saturation was 97%. She was bradycardic, with a sinus rhythm of 76 beats per

minute (bpm). Her non-invasive blood pressure was 72/42 mmHg. Her pupils were dilated. Repeated average rectal temperature measurement revealed 25.7°C.

We noted stress-induced transient hyperglycemia of 18.6 mmol l^{-1}. Peripheral i.v. access was not obtained on the first attempt. Tibial intraosseous (i.o.) access (Arrow® EZ-IO R PD 15 mm) was successful. The neonate received a bolus of 20 ml kg^{-1} of heated crystalloids mixed with glucose 5%. To avoid rescue collapse or arrhythmia she was carefully transported in a horizontal position to a tertiary referral center. To decrease further heat loss, the air was heated, and she was wrapped in warm blankets, with an electrical heating blanket on top. Heating pads, surrounded by compresses, were placed on the groin, the torso and the head. The patient was quickly rewarmed (7°C in one hour). While she remained relatively bradycardic, no arrhythmia was observed, and respiration remained sufficient during this time. Atropine sulfate 0.1 mg i.v. was administered when the body temperature reached 30°C. The heart rate rose from 87 bpm to 105 bpm (Fig. 1).

On arrival in the emergency department, the patient's core temperature had risen to 32.2°C. All vital signs were stable (blood pressure 90/47 mmHg, heart rate 115 min^{-1}, peripheral oxygen saturation 97%). The initial capillary blood gas measured at 37°C showed a pH of 7.25, base excess of 7.4 mmol L^{-1}, lactate of 5.2 mmol l^{-1}, and blood glucose of 19.8 mmol l^{-1} (357 mg dl^{-1}). During further rewarming in the pediatric intensive care unit the neonate continued to breathe spontaneously and remained hemodynamically stable. Twelve hours after the initial resuscitation she began to develop respiratory distress syndrome, which was successfully treated with high-flow nasal cannula therapy. The infant was transferred to the neonatology ward and was able to leave the hospital without any complications after seven days.

Literature review The World Health Organization (WHO) defines neonatal hypothermia as mild at a core temperature of 36.0–36.5°C, moderate at 32–36°C and severe below 32°C.[1] In neonates, hypothermia is associated with significant mortality and with morbidity such as sepsis, metabolic acidosis, respiratory distress syndrome, hypoglycemia and intra-ventricular hemorrhage.[2] Neonates are prone to rapid heat loss because of a large ratio of surface area to volume, decreased subcutaneous fat mass, greater body water content, and immature, thin skin leading to increased evaporative water and heat losses.[2,3] When a newborn is exposed to a cold environment, it attempts to maintain its body temperature by increasing cellular metabolism through voluntary muscle activity, and chemical, non-shivering thermogenesis caused by brown fat tissue and vasoconstriction.[4]

Increased cellular metabolism in neonates leads to increased glucose utilisation, rapid depletion of glycogen stores, and in particular a risk of hypoglycemia. Hypoglycemia is counteracted by decreasing insulin production while simultaneously increasing glucagon, epinephrine, growth hormone and cortisol secretion. This may contribute initially to hyperglycemia, as seen in our case. During rewarming, there is increased responsiveness to insulin and increased glucose consumption, leading to a higher risk of hypoglycemia.[3,4,5] Therefore, we gave dextrose-containing fluids to this hyperglycemic newborn. The

increased cellular metabolism also leads to increased oxygen consumption and pulmonary vasoconstriction. Accompanied by hyperventilation, the hypothermia-induced leftward shift of the hemoglobin-binding curve is increased, preventing adequate oxygen release from hemoglobin and exacerbating tissue-level hypoxia. In combination with the catecholamine-induced peripheral vasoconstriction, the anaerobic metabolism may increase elevation of lactate and metabolic acidosis.[4]

The newborn in our case was bradypnoeic, but did not show any signs of respiratory distress or cyanosis. Therefore, we decided not to intubate, and instead observed the clinical development with intubation on standby. Even for the pediatric anesthesiologist, tracheal intubation in neonates and small infants is a technically difficult skill that must be mastered with the highest possible first-attempt success rate and the largest possible margin of safety. Although it is lifesaving for many children with circulatory shock or acute respiratory failure, tracheal intubation is potentially associated with a risk of severe desaturation[6] resulting in hypoxic encephalopathy, cardiac arrest[7,8] and death[9]. Neonates are prone to hypoxemia that occurs within seconds after cessation of spontaneous or assisted ventilation.[10] The younger the child, the shorter the apnea time before desaturation occurs.[11] In emergent situations, the complication rate surrounding intubation increases substantially,[6–9] resulting in treatment with the potential to do more harm than good.

The heart rate is reduced by around 10 bpm/°C reduction in core body temperature through a decrease in spontaneous depolarization of the pacemaker cells.[4] A heart rate of 70–80 bpm is therefore physiological at a core temperature of 25°C in a neonate. As a result, no CPR was initiated. In resuscitation guidelines it is known that no drugs should be given until the patient has been warmed to a core temperature ≥ 30°C due to the slowed drug metabolism, which can lead to potentially toxic plasma concentrations of any drug given.[12] As our newborn was too bradycardic at a core temperature of 30°C she received atropine 0.1mg i.o. Under this treatment, the increase in heart rate was adequate (Fig. 1).

Regardless of core temperature, even among newborns, the presence of vital sign abnormalities or changes in level of consciousness are the most important factors in deciding how to treat accidental hypothermia.[5] Successful out-of-hospital resuscitation requires rapid attention to supportive care (airway, breathing, circulation), clinical assessment, and treatment of injury or other medical conditions, and depends on effective rewarming interventions with active external (forced air rewarming, radiant heat, chemical heat pads) and minimally invasive rewarming techniques (warmed crystalloids).[5] In the presence of severe hypothermia, out-of-hospital management includes minimal and cautious movements in a horizontal position to avoid life-threatening arrhythmia or rescue collapse.[5]

During rewarming, the electrocardiogram and core temperature should always be monitored.[12] Recent studies have shown a favorable outcome for hypothermic infants admitted to a well-equipped intensive care unit and treated with rapid external warming.[13,14]

Conclusions

As not many emergency physicians and anesthesiologist are faced with such a situation, we would like to emphasize, that the clinical parameters as heart frequency, blood pressure, respiration and consciousness must be interpreted in the light of the measured temperature. The provider would normally be concerned about the bradycardia, but realize this is appropriate relative to the patient's core body temperature. Medical treatment should be carried out as cautiously as possible to avoid arrhythmia or rescue collapse. Although there may be hypothermic neonates that require more aggressive resuscitation external rewarming in a newborn is an effective measure to treat severe accidental hypothermia. Finally, we want to make providers attentive to perform watchful airway management to help prevent critical events.

Abbreviations

°C degree Celsius

g gram

mmHg millimeters of mercury

bpm beats per minute

% percent

mmol l^{-1} millimole per liter

i.v. intravenous

i.o. intraosseous

ml kg^{-1} milliliter per kilograms

min^{-1} per minute

mg milligram

pH potential of hydrogen ions

mg dl^{-1} milligram per deciliter

WHO World Health Organization

bpm/°C beats per minute per degree Celsius

CPR cardiopulmonary resuscitation

≥ greater than or equal to sign

Fig. Figure

Declarations

Ethics approval: Not applicable.

Consent to participate : Informed consent to publication was obtained from the legal guardian.

Availability of data and material : The datasets are available from the corresponding author on reasonable request.

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Authors' contributions : AK was the emergency physician and wrote the first draft of the manuscript. TR was the pediatric anesthesist on duty, was writing the part about the airway management, and was revising the manuscript. GE helped to interpret the data and to design the manuscript. He revised the manuscript and provided important intelectuall content. All authors read and approved the final manuscript and meet the criteria for authorship established by the ICMJE.

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Figures

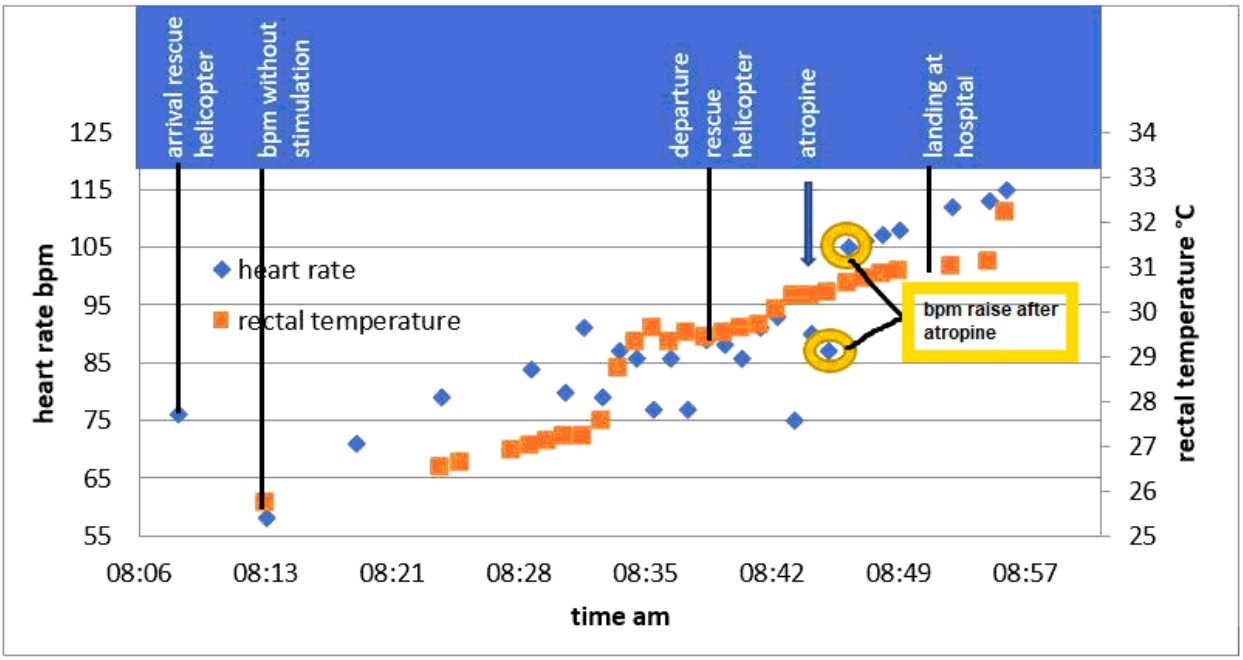

Figure 1

The course of rectal temperature and heart rate during transportation to the hospital.

Supplementary Files

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- Casereporthypothermia020221.pdf