CASE REPORTS

Use of the infant transwarmer mattress as an external warming modality in resuscitation from hypothermia

M Ryan, T F Beattie, K Husselbee, J Freeman

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Normothermia must be established in drowning victims before death may be declared, as the myocardium may remain resistant to stimulation at subnormal temperatures, and complete neurological recovery from submersion associated hypothermia has been reported. A safe and effective method of external re-warming is described that may prove particularly useful in the paediatric population.

Hypothermia is common in children after near-drowning or drowning and may hamper resuscitation attempts unless treated.¹ Mortality after immersion usually results from hypoxia but paradoxically hypothermia may protect against such injury. Indeed hypothermia has been shown to have a protector effect, particularly in brain injury.²

Because of this, full re-warming must be undertaken in all patients who are not normothermic before death may be declared.³

We describe a case of re-warming of a 3 year old child from a core temperature of 28.8°C using infant transwarmer mattresses combined with forced air re-warming with a Bair Hugger blanket and internal modalities. To our knowledge, this is the first report of the use of these mattresses in the treatment of hypothermia.

CASE REPORT

A 3 year old boy was found in a shallow river near his home in the south east of Scotland in October, having gone missing 15 minutes earlier. The outside temperature on that day rose to a maximum of 19°C (Meteorological Office, UK). He was rescued from the river by passers-by but cardiopulmonary resuscitation (CPR) did not start until 15 minutes later when paramedics arrived at the scene.

He was transferred by helicopter to the regional paediatric emergency department. Duration of transfer was about one hour. CPR continued during transfer but active re-warming did not start until arrival at the emergency department. On arrival, he was unresponsive with a Glasgow Coma Scale of 3. Pupils were fixed and dilated. He was very poorly perfused and was asystolic. His core temperature was measured using a low reading rectal thermometer at 28.8°C. There was a superficial abrasion on the bridge of his nose, but examination revealed no other injuries. His abdomen was notably distended.

He was intubated and ventilation started with 100% oxygen. A nasogastric tube was placed to decompress the stomach. Intraosseous access was obtained and re-warming measures were instituted. He received 20 ml/kg warmed intraosseous 0.9% saline over 30 minutes. A urinary catheter was placed and the bladder irrigated with warmed 0.9% saline in 20 ml aliquots.

Two infant transwarmer mattresses were placed—one around the head, and one under the trunk. In addition, a Bair Hugger blanket was placed over the patient.

Figure 1 Re-warming over time.

His temperature rose initially by 2°C in the first hour and then steadily by about 1°C every hour (fig 1).

CPR continued throughout and epinephrine was administered at five minute intervals.

After administration of epinephrine at a temperature of 31.2°C, and after 2.5 hours of CPR, the patient developed ventricular fibrillation. He was defibrillated (2 J/kg) and resultant pulseless electrical activity was noted. A further dose of epinephrine was administered and sinus bradycardia with palpable output established. His heart rate increased gradually and cardiac output improved over the next five minutes.

The patient was transferred to the paediatric intensive care unit for further monitoring. He continued to warm to a maximum temperature of 38°C by hour 11 after admission.

By this stage there was evidence of extensive tissue hypoxia, with abnormal liver, renal, and ventilation parameters. In addition cerebral function analysing monitoring revealed an isoelectric brain trace. After discussion with carers and family, supportive care was stopped 12 hours after the initial accident and the patient was declared dead.

DISCUSSION

The overall rate of drowning for adults and children in south east Scotland has been estimated at 1.6 per 100 000 population.⁴ Despite vigorous attempts at injury prevention, drowning and subsequent hypothermia remain an ongoing cause of morbidity and mortality in children. Complete recovery with intact neurological function has been described⁵ and while some prognostic factors have been closely correlated with a poor outcome⁶ these are not sufficiently predictive to abandon resuscitation before restoration of normothermia.

The most important intervention in these patients remains the institution of adequate and effective CPR.⁶ However myocardium may not respond to stimulation with drugs at subnormal temperatures, and re-warming remains an integral part of management.

Modalities of re-warming remain controversial, and experience with external methods of re-warming in the past has

been variable, although many authors now report increasing success with external modalities.⁷

Other previously well reported methods of re-warming include fluid resuscitation with warmed intravenous fluids, peritoneal lavage,⁸ cardiopulmonary bypass,⁹ and extracorporeal membrane oxygenation.¹⁰ External modalities that have proved effective have included forced air re-warming¹¹ and other warming blankets.¹²

Internal methods of re-warming are complicated by the need for, at the very least, intravenous access and, in complicated cases large intravascular catheter insertion, heparinisation, and provision of trained staff. Disadvantages of conventional external methods include difficulty in keeping the mattress in situ over the patient while CPR and other procedures are taking place.

One previous study has shown no difference in re-warming using external (convective air re-warming) compared with internal (warmed intravenous fluid) methods.¹³ While the study size was limited, it may be that external methods alone may be just as effective in trying to warm these patients.

Other authors have described the effective use of the Bair Hugger blanket in re-warming five hypothermic patients. All were successfully resuscitated, with no recourse to expensive and labour intensive cardiopulmonary bypass.^{14, 15} In addition, the previously described complication of temperature after-drop was not seen.

TRANSWARMER MATTRESS

This is a 25×41 cm mattress filled with sodium acetate, a food grade salt. A disc is situated internally. Clicking of the disc releases a molecule from the surface of the disk that starts a crystallisation process in the mattress. Heat is released as a byproduct of this reaction. The mattress heats to an operating temperature of 38°C, which is maintained for a minimum of two hours. The other contents of the mattress are non-toxic gelling agents and stabilisers, which ensure the mattress does not exceed its maximum temperature of 40°C, thereby reducing the risk of thermal injury.

The infant transwarmer mattress was originally provided at our hospital for use in the transfer of paediatric intensive care unit patients. It is easily portable, maintains heat for extended periods of time, and may be placed under the patient for ease of access. It remains flexible, even in the activated state, and may be moulded around the patient. The cost of each mattress is £17.

We found it difficult to keep the Bair Hugger blanket placed over the patient without disturbance, while the transwarmer mattress could be placed under the patient providing easy access to the patient without compromising re-warming.

Furthermore, it requires no further involvement of staff, freeing them for other tasks.

We were able to place another mattress around the patient's head, which may be a particularly important source of heat loss in children, in whom a much larger surface area of the body is taken up by the head.

Despite the ultimately unsuccessful outcome in this case the re-warming aspect was easily achieved. To our knowledge, the use of these mattresses for this purpose has not previously been described. Although the mattress is of comparatively small size, multiple mattresses may be used to provide heat over even larger patients. We believe they will prove a useful adjunct to the management of severely hypothermic patients, in particular children.

Authors' affiliations

M Ryan, T F Beattie, Paediatric Emergency Department, Royal Hospital for Sick Children, Edinburgh, UK

K Husselbee, J Freeman, Paediatric Intensive Care Unit, Royal Hospital for Sick Children, Edinburgh

Correspondence to: Dr M Ryan, Paediatric Emergency Department, Royal Hospital for Sick Children, Edinburgh EH9 1LF, UK; maryryan@blueyonder.co.uk

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