HealthManagement
Promoting Management and Leadership

Volume 9, Issue 2 /2007 - Med Tech

Induced Hypothermia and Fever-Control in Neurological Injury

Contact Information:

Kees H. Polderman, *MD, PhD*

Vice Chairman,

Department of Intensive Care

University Medical Center Utrecht, The Netherlands

Tel.: +3130 2503261

Fax: +3120 7620294

Email: k.polderman@tip.nl or

k.polderman@umcutrecht.nl

In recent years the issue of temperature management in critically ill patients, in particular those with neurological injuries, has gained increasing attention from the critical care community. An increasing body of evidence has shown that the development of fever in patients with various types of neurological injury is associated with an increased risk of adverse outcome. This has been shown most clearly in patients with ischemic stroke, where the absolute risk of adverse outcome (death or permanent neurological impairment) increases by 2.2% for every degree of temperature increase. A link between fever and adverse outcome has also been reported in patients with other types of brain injury, such as traumatic brain injury, subarachnoid haemorrhage, and post-ischemic injury following cardiac arrest. The fact that these associations persist after multivariate analysis suggests that the relationship is causal, i.e. that fever generates additional brain injury. This view is reinforced by observations from various animal experiments, which have shown that the extent of experimentally-induced neurological injuries increases significantly if the animal is (externally) warmed. The risk conferred by fever appears to be independent its cause; infectious fever, “central” (neurological) fever, and fever occurring during reperfusion injury are all linked to increased neurological injury.

Protectiveness of Hypothermia

If hyperthermia is harmful to the injured brain, it seems reasonable to assume that perhaps hypothermia could be protective. Indeed, it is becoming increasingly clear that induction of mild hypothermia (lowering of body temperature to between 32°C and 34°C) in the hours following injury can be neuroprotective, particularly in patients with post-anoxic injury. Hypothermia can be applied in numerous clinical situations; it has been used to decrease intracranial pressure (ICP) in patients with traumatic brain injury or ischemic stroke, to mitigate myocardial injury following myocardial infarction, to reduce the inflammatory response in ARDS, and in numerous other situations. However, positive effects of hypothermia have been most convincingly demonstrated in patients with global post-ischemic brain injury. Two multi-centred RCT’s have shown improved outcomes associated with cooling in newborn babies with post-anoxic injury due to perinatal asphyxia; two RCT’s have shown benefits in adult patients who remained comatose after a witnessed cardiac arrest, who had an initial rhythm of ventricular fibrillation (VF) or ventricular tachycardia (VT). Regarding the latter category, the European Resuscitation Council (ERC) has recently incorporated the use of induced hypothermia in selected patients following cardiac arrest into the ERC guidelines for resuscitation.

In the United States around 400,000 patients/year have a cardiac arrest; the number in Europe is similar. Between 20% and 38% of these patients have VF or VT as the first recorded rhythm. With appropriate emergency care around 70% of these patients can reach the hospital alive. Thus the group of patients with a potential indication for induced hypothermia is fairly large, particularly if all cardiac arrests patients admitted to the ICU were to be treated with induced hypothermia (as is the current policy in most units already using hypothermia as a medical treatment).

Calculations regarding the number needed to treat (NNT) to achieve one additional patient with favourable neurologic outcome have put this number at six. This figure is likely to be conservative, because in the abovementioned studies the time intervals until initiation of cooling and achievement of target temperature were relatively long (8 hours in the largest adult study, 6 hours in the neonatal studies). The effects of hypothermia are likely to be greater if treatment is started earlier and cooling rates are faster. However, using the NNT of 6 as a basis for calculations, hypothermia treatment appears to be highly cost-effective in most settings. The prices of the currently available cooling devices range from Û10,000 to Û48,000, roughly comparable to the price of a mechanical ventilator.

Cost-Effectiveness of Cooling Devices

The efficacy of the different cooling devices varies considerably; efficacy can be judged based on the speed of cooling, ability to maintain target temperature within a narrow range, ability to achieve slow and controlled rewarming, and absence or low frequency of side effects. Most cooling devices use disposable materials (surface cooling pads or intravascular catheters) to cool patients; one device uses (partly) re-usable cooling pads. The prices for these disposable materials range from Û90 to Û800 per patient.

However, the cost-effectiveness of cooling devices should not be judged solely on the basis of their purchase price and the price of the disposables. The associated workload of the medical and nursing staff is of equal and perhaps even greater importance. The amount and type of workload required for effective use of the cooling devices that are commercially available varies considerably. Which device is most appropriate and cost-effective in a specific setting will depend strongly on that setting. In this regard, there will be considerable differences between low-volume and high-volume ICU's. High-volume units may simply be large hospitals with large numbers of ICU beds, and/or units that treat many patients with hypothermia, perhaps for different indications. Units that use cooling devices for indications other than cardiac arrest, to treat patients with traumatic brain injury or to control fever in patients with neurological injuries, will usually need more than one cooling device, as these patients usually require treatments of longer duration.

Naturally, the costs per patient will vary considerably, and will be determined by the factors listed above. For high-volume units a relatively expensive device, with cheaper disposables, may be the best choice, whereas a low-volume unit may opt for a cheaper device with more expensive disposables. Depending on the volume of patients, the costs per patient may vary from Û1,000 per patient in a very low-volume setting to less than Û200 per patient in high-volume units. With a NNT of 6 for one additional patient with a favourable outcome, without an increase in the length of stay, it becomes clear that hypothermia is indeed one of the most cost-effective treatments currently available in intensive care. Even when using the price at the top end of the range above (Û1,000 per patient) to calculate the overall costs, this would require an investment of Û6,000 to save one patient; the price per quality-adjusted life-year would still be less than Û900. This compares highly favourably with many routine interventions in the critical care setting. As the actual price per patient will be significantly lower in most settings, cooling devices will be a worthwhile investment.

Published on : Sat, 24 Feb 2007