Is enteral feeding tolerated during therapeutic hypothermia?

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Abstract

Objective

To determine whether patients undergoing therapeutic hypothermia following cardiac arrest tolerate early enteral nutrition.

Methods

We undertook a single-centre longitudinal cohort analysis of the tolerance of enteral feeding by 55 patients treated with therapeutic hypothermia following resuscitation from cardiac arrest. The observation period was divided into three phases: (1) 24 h at target temperature (32-34°C); (2) 24 h rewarming to 36.5°C; and (3) 24 h maintained at a core temperature below 37.5°C.

Results

During period 1, patients tolerated a median of 72% (interquartile range (IQR) 68.7%; range 31.3 to 100%) of administered feed. During period 2 (rewarming phase), a median of 95% (IQR 66.2%; range 33.77 to 100%) of administered feed was tolerated. During period 3 (normothermia) a median of 100% (IQR 4.75%; range 95.25 to 100%) of administered feed was tolerated. The highest incidence of vomiting or regurgitation of feed (19% of patients) occurred between 24-48 h of therapy.

Conclusions

Patients undergoing therapeutic hypothermia following cardiac arrest may be able to tolerate a substantial proportion of their daily nutritional requirements. It is possible that routine use of prokinetic drugs during this period may increase the success of feed delivery enterally and this could usefully be explored.

Introduction

Clinical guidelines issued by the National Institute for Health and Care Excellence (NICE) identify critically ill patients as at risk of malnutrition attributable to inadequate oral intake, poor gastrointestinal absorption or increased nutritional requirements due to catabolism.[1] To meet energy requirements, a baseline of 25-30 kcal/kg enteral feed is advised. Early enteral feeding has been advocated to prevent malnutrition in hypercatabolic states.[2] Further benefits include enhanced wound healing, reduced incidence of infection, and maintenance and function of the gastrointestinal tract including the reduction of organism translocation.[2,3,4,5] Timely provision of nutrition is therefore a routine component of care; however, recommendations for patients undergoing therapeutic hypothermia (TH) are less clear.

Some authors advise that nutrition should not be provided during TH, including the induction, maintenance or re-warming phase of the therapy,[6,7] while others imply that nutrition can be provided but at reduced volume, which reflects the reduced demand associated with the low basal metabolic rate induced by hypothermia.[8]

An ischaemic injury initiates a cascade of free radicals on reperfusion, which can exacerbate tissue injury.[9] During cardiac arrest severe intestinal ischaemia occurs causing translocation of bacteria and endotoxins[10,11] and early intestinal dysfunction ensues.[12] Critical illness and hypothermia are reported to delay gastric emptying and decrease peristalsis causing ileus/stasis;[9,13,14] both contributing to intolerance of enteral feed. Reports state the incidence of ileus in critical illness to be between 50-80%,[15] delayed gastric emptying to occur in 70% of mechanically ventilated patients[16] and gut dysfunction in 60% of patients after out-of-hospital cardiac arrest.[17] However, there are no published data addressing the tolerance of enteral feed by patients undergoing TH after cardiac arrest.

On our intensive care unit (ICU), we routinely attempt early enteral feeding in patients undergoing TH. This descriptive study therefore set out to examine whether early enteral nutrition is tolerated by hypothermic patients following cardiac arrest.

Methods

The hospital’s research and development department granted retrospective access to nursing notes and electronic Intensive Care National Audit and Research Centre (ICNARC) records. As this study is a form of service evaluation, patient care was not altered (or alterable) in any way and all data was anonymous, ethical approval was not required.

The study took place in a single mixed ICU in a district general hospital with considerable experience and stable protocols for the management of TH in patients following cardiac arrest. Potential participants were identified using the local dataset of the ICNARC database and included patients admitted to the Royal United Hospital, Bath ICU between April 2006 and December 2010.

Exclusions preventing TH include pre-existing coagulopathy or internal bleeding, pregnancy, established multi organ failure, and severe systemic infection. These have been established criteria since cooling was introduced in 2002. Both the management of TH and of enteral nutrition are performed according to local protocols. All patients were sedated with propofol (1-3 mg kg^{-1} h^{-1}) and alfentanil (10 – 50 mcg kg^{-1} h^{-1}) until return to normothermia. Hypothermia was induced and maintained with the *Alsius Coolgard 3000* (Zoll Medical Corporation, Massachusetts, USA) and an indwelling femoral cooling catheter. Core temperature was recorded using a *Tyco Thermistor 400 series* (Tyco Healthcare, California, USA) bladder catheter (integrally connected and continuously displayed via the Coolgard). Enteral feed was delivered via a *Nutricia Flocare Infinity* (Nutricia Ltd, Trowbridge, Wiltshire, UK) continuous feeding pump. All patients received *Nutricia Nutrison standard* feed formula of 1Kcal/ml (Nutricia Ltd, Trowbridge, Wiltshire, UK).

The therapeutic hypothermia process can be divided into three distinct phases: (1) 24 h at target temperature (32-34°C); (2) 24 h rewarming to 36.5°C; and (3) 24 h maintained at a core temperature below 37.5°C.

The local ICNARC data set was searched to identify patients admitted to the ICU who had a core temperature of 34°C or less, a Glasgow Coma Score (GCS) of less than 8, and a record of cardiopulmonary resuscitation (CPR). This search identified

120 patients. Further checks were performed to exclude any patients who did not undergo TH, or who did not complete a 72 h period of TH as described above. 55 patients were identified.

Demographic details were extracted from the local ICNARC dataset: age, gender, admission date, in hospital (IH) or out of hospital (OOH) cardiac arrest, and Acute Physiology and Chronic Health Evaluation II (APACHE II) score. The APACHE II score reflects the severity of acute physiological disturbance and chronic disease on admission.[18] Data on enteral feeding, (timing, success or failure, vomiting events or increased gastric aspirate volumes) and body temperature was retrieved from nursing observation charts, forming an essential legal record of ICU care and patient status. Complete records were therefore anticipated though accuracy may not be guaranteed.

Data extraction for the purposes of the study commenced when the patient reached the target temperature of 32 to 34°C. The total volume of feed administered and volume of gastric aspirates during the three phases of the hypothermic therapy was extracted. The duration for data collection on each patient was 72 h. Any incidences of vomiting or regurgitation were also noted as a further sign of gastric intolerance.

The volume of enteral feed delivered was recorded as the volume administered enterally after subtracting the volume of any discarded aspirate (returned aspirate was discounted). This was then converted to a percentage of delivered feed. Some patients had large gastric aspirates that exceeded the volume of enteral feed administered resulting in a negative administration data. It was deemed necessary to include these negative data as it could not be determined whether aspirates were feed or bile or a mixture. The volume of feed tolerated (successfully delivered enterally) during each of the three phases of hypothermia was recorded. Failure to tolerate feed was deemed to have occurred if the volume of gastric aspirates exceeded the volume delivered or if the patient vomited.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 19. Correlations between absorption of feed and APACHE II scores, age and gender were explored using a Spearman Rank test.

Results

The sample consisted of 55 patients between the ages of 20-85 years (median 68). The median APACHE II score was 18 (range from 12 – 34). There were 35 males and 20 females. One patient was not fed for the entire 72 h period being studied and feeding was not attempted for at least one day in a further eight. Data have been presented for all patients for whom these were available for each 24 hour period (Table 1 and Figure 1). All patients were fed nasogastrically. There was no correlation between volume of feed tolerated and APACHE II scores ($r = 0.052$; $P = 0.708$), age ($r = 0.005$; $P = 0.972$), and gender ($r = 0.004$; $P = 0.979$).

During phase one (cooling), 43 (83%) patients tolerated some feed and nine (13%) had net negative gastric aspirates (aspirate volumes exceeding the volume of administered feed by 25% to 327%). During phase 2 (rewarming), 43 (83%) patients tolerated some feed and nine (13%) had net negative gastric aspirates. During phase 3 (normothermia), 43 (91%) patients tolerated almost all administered feed and four (9%) had net negative gastric aspirates (aspirate volumes exceeding the volume of administered feed by 10% to 204%).

Discussion

Our study shows that more than 80% of patients tolerate at least some enteral feed during all three phases of TH; however, several patients (nine on day 1, nine on day two and four on day 3) produced a volume of discarded gastric aspirates that exceeded nutritional input.

At core temperatures of 32-34°C, patients tolerated a median of 72% of administered enteral feed which represents median feed volumes of 243 ml per 24 h or approximately 10 ml/h. Standard enteral feeds provide 1 kcal/ml energy. An average 75 kg male would require 1875 ml of feed per 24 h; 240 ml would account for approximately 12% of normal daily energy requirements. During the cool phase, five patients vomited/regurgitated while almost a fifth of patients produced gastric aspirates that exceeded nasogastric input. These findings suggest a significant number of patients in this phase have gastric stasis and are intolerant of enteral feeding.

During the rewarming phase from 24-48 h, the patients were rewarmed at 0.25°C/h meaning that patients would have had a core temperature below 36°C for at least 10 h of this phase. During this phase, most patients tolerated almost all of their feed (median 95%) but vomiting/regurgitation occurred in 19% and almost one fifth of patients still had high gastric aspirate volumes. Prokinetics were generally not given during phase 1 or 2 of therapy (0-48 h) as this was not usual practice.

Underfeeding limits the outcome benefits of early enteral feeding. Although our staff usually follow a feeding protocol, this was seldom followed for patients undergoing TH. Components of the protocol including the regularity of checking gastric residual volumes and incremental increases in feed rate to an individualised, weight-related maximum dose were practised inconsistently. Many nursing staff provided nutrition at a reduced rate (10-30 ml/h) while few appropriately increased the rate (by 30 ml increments) when aspirates were minimal (<200 ml every 4 h).

Most patients tolerated a high proportion of the feed that was administered; many of these may have been able to tolerate a higher volume but because the feeding protocol was often not followed, we were unable to evaluate this reliably. Forty percent of our cohort had gastric aspirates that exceeded delivered nutrition on one or more days of the study period. A high incidence of ileus or delayed gastric emptying is well documented in the critically ill and targets for enteral nutrition are frequently not achieved.[15,16,17]

In the presence of gastric stasis, post-pyloric feeding may enable successful delivery of enteral feed[19] and this strategy might usefully be studied in post cardiac arrest patients. The routine use of prokinetics throughout TH may increase the tolerance of enteral feed.

A separate feeding protocol for post cardiac arrest patients undergoing TH, would provide clear instruction and a rationale for reduced rates of feeding, as well as how to assess the success of enteral feeding in this group.

Strengths and limitations

This is first study to specifically examine the possibility of feeding hypothermic patients post arrest. We included a reasonable sample size, which represented the post cardiac arrest patients that were cooled in our ICU over a 4-year period and survived at least 3 days. Only two patients' records could not be located and considered for inclusion. All other records were complete.

Our data reflect the feeding practices of only one ICU and was collected retrospectively. The study is descriptive, preventing any control of feeding practices. Although we documented the volume of feed delivered successfully (tolerated), we have no way of knowing whether this feed was actually absorbed from the small bowel. The ratio of feed to endogenous secretions was impossible to determine and by assuming that all discarded aspirate was feed it is likely that our data underestimate the degree of absorption. We have no data on confounders such as past medical history (especially related to gastrointestinal disorders) or the technique used when aspirating gastric contents. The use of alfentanil for sedation is also likely to have reduced the tolerance to enteral feeding. Our sample size was too small to enable any useful study of survival.

Prospective studies are required to assess the value of enteral feeding during TH. Earlier, routine use of prokinetics may improve the tolerance of larger volumes of feed but this requires evaluation prospectively. Ultimately, there is a need to understand the metabolic requirements of cooled patients so that delivery of nutrition can be optimised.

Conclusion

Most post cardiac arrest patients treated with TH tolerate at least a proportion of administered enteral feed. Feed is progressively better tolerated as patients are rewarmed. A reduced rate of feed should be considered when patients are at the target temperature of 32-34°C. The feed rate can be incrementally increased once the patient's temperature has increased to normothermia.

Conflict of Interest Statement

None.

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Legend

Figure 1**.** Median volumes (mL) of feed administered and tolerated in each 24 h period.

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