

Is bolus or continuous enteral feeding better in critically ill children: an evidence-based review

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Abstract

Inadequate nutrition can lead to increased morbidity and mortality for mechanically ventilated children in the Paediatric Intensive Care Unit [PICU]. Enteral feeding can either be delivered by gravity bolus (Intermittent) feeding or continuously via a pump and in UK PICUs variable practice exists. The aim of this evidence-based review is therefore to examine the evidence surrounding the two feeding methods for ventilated children, to determine whether one provides better enteral nutrition. Four papers were included, three RCTs and a systematic review, which provide conflicting evidence. There is some suggestion that bolus feeding may be superior in medical children on PICU to achieve their energy and protein goals faster, however the clinical significance of the results is questionable and further research is needed to identify whether one method of feeding can impact on patient outcomes.

Background and clinical question

Delivering sufficient enteral nutrition can be a challenge within the paediatric Intensive Care Unit [PICU] and while most children on PICU are enterally fed, methods and practices vary widely (1). Malnutrition and poor feeding in critically ill children is increasingly associated with an increase in morbidity and mortality (2-6), a higher risk of ventilator-associated pneumonia (2,5), poor skin integrity/wound healing (6) and muscle weakness (6). In addition to this, inadequate nutrition can prolong the duration of required mechanical ventilation, which in turn increases duration of PICU stay (3-6). Two methods of delivering enteral feeding are used: intermittent bolus feeding (by gravity) or over a short duration at a variety of intervals most commonly 2-4 hourly, and continuous pump feeding, and in the UK just over half of PICUs use continuous feeding preferentially (7). This poses the question of is one feeding method: continuous versus bolus more effective at providing optimal nutrition for ventilated children on PICU?

Search Strategy

Prior to completing literature searches, important outcomes were considered to determine how the success or failure of each feed method could be measured. These were based around feed tolerance and included measurement of gastric residual volume [GRV], time taken to reach a specified feed goal, incidence of ventilator associated pneumonia [VAP], and episodes of diarrhoea and vomiting. This enabled a search strategy to be formulated that included key search terms for the measurable outcomes as well as the population and intervention. The HDAS, CINAHL, and PubMed databases were searched with the keywords: paediatric/child/children/infants, feeding/method/bolus/continuous, gastric residual volume, feed tolerance, and ventilator associated pneumonia,

with searches limited to the last 15 years. Our search identified five original studies and a systematic review, but two of the studies were excluded as they were over 15 years old and were already included within the systematic review. One of the papers included was also included in the systematic review but has been analysed separately as well. This review on based on four relevant and recent papers (Table 1).

Review of the evidence

Two of the studies are Randomised Controlled Trials (RCTs), with one randomised comparative effectiveness study with children randomised to bolus feeds or continuous feeds and one systematic review. All trials measured time taken to achieve a set feed goal, and feed intolerance based on GRV and episodes of vomiting. No papers were identified that assessed the incidence of VAP.

Table 1: Evidence Table

Study	Aim and method	Key results	Strengths	Limitations
Fayazi et al, 2016. Iran	Randomised controlled trial. Aim to assess time taken to reach calorie goal, episodes of diarrhoea and vomiting, feed tolerance, and length of PICU stay. Sample: 60 children aged 5-17 years.	Mean time to reach calorie goal was higher in in the continuously fed group ($p=0.001$). The percentage of patients experiencing episodes of intolerance (large gastric residual volume) was reduced with continuous feeding ($p=0.02$). Other outcomes were not significantly different	Clear aims and objectives, sample size calculation presented.	Single centre study. Did not include children under 5 years GRV>100mls was considered feed intolerance
Brown et al, 2018. USA	Prospective comparative effectiveness pilot trial. Aim to assess time taken to reach full feed volume and energy intake, episodes of intolerance, and feed interruptions. Sample: 25 children aged 1 month-12 years.	At 24 hours, the bolus fed group had reached a higher energy and protein intake ($p=0.007$) Other outcomes were not significantly different	Clear aims and objectives. used computerised block randomisation, included children less than 5 years old and both groups had a standardised protocol for feed advancement	Single centre, Pilot study with small sample size. 11 of the 25 subjects were only assessed for 24 hours due to extubation and advancing to oral feeding.
Brown et al, 2020. USA	Systematic review 5 papers included in review Differences in feeding regimes between the papers, with many not reporting nutritional outcomes Two of the articles described findings from the same study population.	Although 4 of the 5 studies randomised children to bolus versus continuous feedings, only 3 studies described attainment of nutrient delivery goals in both the intervention and the control groups; the remaining study did not report this outcome One paper identified that gastric residual volumes were higher in continuously fed patients ($p=0.008$).	Extensive search strategy and analysis. Independent analysis and review process by multiple researchers.	Only 2 of the included papers were less than 10 years old. Unable to combine results from the papers due to differences in methods and measurable outcomes.

	Combined sample size of less than 200 children.	One paper identified that bolus fed children were receiving a higher energy intake after 24 hours ($p=0.001$). No other significant results were identified.		
Brown et al, 2022. USA	Randomised controlled trial. Aim to assess time taken to reach full feed goal, and calorie/protein intake. Sample: 158 children aged 1 month – 12 years.	The bolus fed group reached their feeds goal faster, which improved calorie and protein intake ($p=0.032$).	Multi-centre study. Appropriate block randomisation. Large sample size.	Included medical patients only, no surgical patients.

The first paper [2] a RCT by Fayazi et al, was the only study to find that continuously fed patients reached their feed goals (based on the Harris-Benedict Equation) faster ($p=0.001$) and this method led to fewer episodes of intolerance based on GRV ($p=0.02$). However, the GRV used to define feed intolerance was $>100\text{mls}$, which might be reasonable for a 5-year-old (average weight 18Kg) but not for a 17-year-old. As around 60% of their sample was aged over 11 years this will have affected this outcome, and thus might be misleading. Consideration must also be made that this study included a much older population than the other studies with no children under 5 years old included (80% of PICU population in the UK is under 2 years [8]). This study also assessed episodes of vomiting and diarrhoea and length of PICU stay but did not find any significant differences. They collected data over a 7-day period for each child. This study had a relatively large sample size (60 children) when compared to other studies but was a single centre study.

Brown et al in 2018 [7] conducted a prospective, randomised comparative effectiveness intervention pilot study using computerised block randomisation, but had a small sample size of 25 patients, 11 of which could only be assessed for 24 hours due to extubation and progress to oral feeding. Energy and Protein requirements were calculated using a combination of the Schofield Equation and the American Society for Parenteral and Enteral Nutrition (ASPEN) guidelines for protein recommendations. The study did find that the bolus fed group achieved a higher energy and protein intake at 24 hours ($p=0.007$) however the relevance of this for patients who are intubated and enterally fed for much longer than 24 hours is unclear. Further results at 48 hours and beyond, could have given more insight into whether that initial attainment of higher energy intake has an impact on the long-term outcomes for patients intubated and tube fed for longer periods.

A systematic literature review undertaken by Brown et al in 2020 [8] included only five studies, three of which are now over 10 years old, and two of which focused on tube position (nasogastric versus nasojejunal) rather than the feeding method itself. The results of the five studies could not be combined due to differences in methods and measurable outcomes, so the results of each study were analysed separately. The review concluded that there were no clear and consistent findings across the studies and that further research was required. At this point in time only conflicting results had been published and all studies completed on this topic were small single centre studies.

However, in 2022, Brown et al conducted a multicentre RCT in the USA [9], with a sample size of 158, which has provided further significant results in support of bolus feeding. This RCT again used a block randomisation process and collected data for up to 10 days or until full feed goals were met for over 12 hours. This study used a combination of ASPEN guidelines for protein recommendations and the World Health Organisation's energy equation to calculate goal energy and protein intake. They included children 1 month – 12 years and found that bolus fed patients reached their feed goal significantly faster ($p=0.038$) and achieved higher median percentage energy (Kcal) and protein targets ($p<0.001$). However, the difference in time was a median time of 18 vs 20 hours, and the clinical significance of this is questionable. It is also noted that this study excluded all surgical patients, and

older children in whom bolus feeding is often impractical due to the volumes required and this highlights areas for further research.

Implementation into practice

These papers provide conflicting results, and despite the largest and most recent RCT [9] suggesting bolus feeding might be advantageous in improving the time to achieve goal feeds, the time difference was so small this is unlikely to confer any clinical benefits. Of note, most of the significant results identified in all the studies are based around time to reach target feed, and very few studies found any significant differences related to other measurable outcomes that could impact on a child's nutrition and longer-term outcomes. Additionally, it must be noted three of the four papers are conducted by one author. Whilst further research is still required into specific population groups such as surgical patients, and on the longer-term impact of each feeding method, the current evidence is not strong enough to recommend one approach over another and pragmatically, the best choice may be related to the PICUs nurse staffing ratios and available feeding equipment (pumps). A systematic review published in 2020 (6) which included a question on optimal feeding method, also concluded neither method was superior, however this did not include the last 2 studies [9,11].

A recent survey of UK PICUs enteral nutrition practices on PICU in 2019 [6], found that just under half (37%) of UK PICUs utilised bolus feeding as their default method, with more using continuous feeding. Current evidence suggests neither method is significantly superior. A more consistent approach to enteral feeding across PICUs would however, enable further research to be conducted to examine which patients might benefit from continuous feeding and to strengthen the existing evidence base. Delivering and assessing the patient's tolerance to enteral feeding is a key nursing role in PICU and the choice of method to feed the child a primary nursing decision. This evidence-based review has reviewed the current evidence on the topic and made recommendations useful for the bedside nurse.

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