

Conservative fluid resuscitation and aggressive enteral nutrition: A potentially lethal combination in patients with critical illness

Intravenous fluid resuscitation (FR) and enteral nutrition (EN) are key early treatments in critical illness, but the interaction between them has not been investigated. Unresolved issues with FR include the optimal fluid, fluid rate and volume, timing and goals for resuscitation.¹ Recommendations range from *conservative*² to *liberal*³ fluid rates which may be modified on the basis of hydration status, estimated blood volume and patient comorbidities. Unresolved issues with EN include the ideal formula, optimal rate, when to start and how quickly to increase the rate. Recommendations range from aggressive (*early normocaloric feeding*)⁴ to less aggressive (*permissive hypocaloric feeding*) or trophic feeding (*trickle feeding*)^{5,6} regimes. Amongst these recommendations, there is a potentially lethal combination: *conservative FR* and *aggressive EN*.

There is growing literature that supports a delayed start and less aggressive EN in vulnerable patients. In the setting of predicted severe acute pancreatitis, the Dutch Pancreatitis Group⁷ compared two feeding protocols, early and late. Early EN within 24 h of admission did not result in a reduction in mortality, infections or organ failure compared with voluntary fluid/food intake up to 96 h. The Critical Care Nutrition Network⁸ suggests that hypocaloric EN is associated with a trend towards reduced mortality and mechanical ventilation duration. Besides, there is evidence to support that this approach was associated with an improvement in gastrointestinal tolerance, without any additional improvements in the intensive care unit (ICU)-related outcomes. This provides some evidence that trophic and/or permissive hypocaloric EN, at least in this context, does not adversely impact outcomes. When early EN has been compared with delayed EN, there is evidence supporting the former in ICU patients. It is notable that recent guidelines now recommend *hypocaloric* feeding rather than *full* enteral feeding in the early phase of critical illness.⁵

Conservative FR with hypovolaemia results in reflex splanchnic vasoconstriction to prioritise the perfusion of vital organs, and intestinal ischaemia can persist even when blood pressure and heart rate have been restored to normal. When aggressive EN is administered in this setting, the risk that an increased metabolic demand from the feed, and the mismatch between oxygen demand and supply can lead to a loss of mucosal integrity (starting at the tip of the villi), ensuing intestinal ischaemia and eventually necrosis, or non-occlusive mesenteric ischaemia (NOMI).⁹ This redistribution of blood away from the intestine to other vital organs can come at a cost and the intestine pays for it. In addition, narcotic analgesia (causing ileus), broad-spectrum antibiotics (dysbiosis) and vasopressors (ischaemia) can worsen intestinal injury.

The risk of *NOMI* may increase with the combination of *conservative FR* and *early aggressive EN*. While clinically apparent, *NOMI* is relatively uncommon and the spectrum of clinical manifestations includes ileus, high gastric residual volumes, feeding intolerance, *pneumatosis intestinalis*, perforation, peritonism, multi-organ failure and death.^{9,10} The early diagnosis of intestinal

ischaemia can be a challenge but an ideal intestinal biomarker is not yet available.^{9,11,12} The lack of an objective tool to diagnose and monitor intestinal ischaemia is probably the primary reason why the intestine is not part of organ-based severity scoring tools (e.g., APACHE II score, SOFA score and modified Marshall).¹³

In conclusion, there is a need to better understand the interaction between FR and EN in the early treatment of critical illness. The correction of hypovolaemia is mandatory before commencing low-dose EN, which is important in reducing the risk of gut dysfunction and intestinal ischaemia. The practical challenge is determining when splanchnic vasoconstriction is no longer present with restoration of normovolaemia so as to indicate that FR is no longer required and it is safe to commence and escalate EN. Until a highly accurate biomarker for monitoring individual patients is available, there appears to be good reasons to avoid aggressive EN, especially in those at risk of intestinal ischaemia. Further studies are warranted to investigate the interaction between protocols of FR and EN in patients with critical illness.

Conflict of interest

Varsha M. Asrani is a current PhD candidate with the University of Auckland and holds a New Zealand Health Research Council Fellowship Award.

Ethics statement

The project has been approved by the Health and Disability Ethics Committee (HDEC: 18/NTA/187) and the Auckland District Health Board research review committee (ADHB-RRC: A+7928).


Author contributions


Colin McArthur: Supervision; writing-review & editing. **Anthony Phillips:** Writing-review & editing. **Ian Bissett:** Investigation; supervision; writing-review & editing. **John A Windsor:** Conceptualization; investigation; supervision; validation; writing-review & editing. **Varsha M. Asrani:** Conceptualization; data curation; funding acquisition; investigation; methodology; project administration; writing-original draft; writing-review & editing.

References

- Dellinger RP, Schorr CA, Levy MM. A users' guide to the 2016 Surviving Sepsis Guidelines. *Intensive Care Med.* 2017;**43**:299–303.
- Myles PS, Bellomo R, Corcoran T, Forbes A, Peyton P, Story D, et al. Restrictive versus liberal fluid therapy for major abdominal surgery. *N Engl J Med.* 2018;**378**:2263–74.
- Bundgaard-Nielsen M, Secher NH, Kehlet H. 'Liberal' vs. 'restrictive' perioperative fluid therapy – a critical assessment of the evidence. *Acta Anaesthesiol Scand.* 2009;**53**:843–51.

4. Heyland DK, Dhaliwal R, Drover JW, Gramlich L, Dodek P, Canadian Critical Care Clinical Practice Guidelines Committee. Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients. *JPEN J Parenter Enteral Nutr.* 2003;**27**:355–73.
5. Singer P, Blaser AR, Berger MM, Alhazzani W, Calder PC, Casaer MP, et al. ESPEN guideline on clinical nutrition in the intensive care unit. *Clin Nutr.* 2019;**38**:48–79.
6. Preiser JC, Arabi YM. Be early for enteral, no rush for calories! *Intensive Care Med.* 2016;**42**:451–2.
7. Bakker OJ, van Brunschot S, van Santvoort HC, Besselink MG, Bollen TL, Boermeester MA, et al. Early versus on-demand nasoenteric tube feeding in acute pancreatitis. *N Engl J Med.* 2014;**371**:1983–93.
8. Heyland D, et al. Critical Care Nutrition recommendations; hypocaloric enteral nutrition. 2015. <https://www.criticalcarenutrition.com/docs/CPGs%202015/3.3b%202015.pdf>. Accessed March 11, 2021.
9. Al-Diery H, Phillips A, Evennett N, Pandanaboyana S, Gilham M, Windsor JA. The pathogenesis of nonocclusive mesenteric ischemia: implications for research and clinical practice. *J Intensive Care Med.* 2019;**34**:771–81.
10. Reigner J, Boisrame-Helms J, Brisard L, Lascarrou JB, Ait Hssain A, Anguel N, et al. Enteral versus parenteral early nutrition in ventilated adults with shock: a randomised, controlled, multicentre, open-label, parallel-group study (NUTRIREA-2). *Lancet.* 2018;**391**:133–43.
11. Stoppe C, Wendt S, Mehta NM, Compher C, Preiser JC, Heyland DK, et al. Biomarkers in critical care nutrition. *Crit Care.* 2020;**24**:499.
12. Evennett NJ, Petrov MS, Mittal A, Windsor JA. Systematic review and pooled estimates for the diagnostic accuracy of serological markers for intestinal ischemia. *World J Surg.* 2009;**33**:1374–83.
13. Asrani VM, Brown A, Huang W, Bissett I, Windsor JA. Gastrointestinal dysfunction in critical illness: a review of scoring tools. *JPEN J Parenter Enteral Nutr.* 2020;**44**:182–96.

Varsha M. Asrani,*†‡ MHS, NZRD, APD
 Colin McArthur,‡ MBChB, FCICM
 Anthony R. J. Phillips,*§ MBChB, PhD
 Ian Bissett,*¶ MBChB, MD, FRACS 

John A. Windsor,*¶ MBChB, MD, FRACS, FRSNZ 

*Surgical and Translational Research (StAR) Centre, Faculty of Medical and Health Sciences, University of Auckland, Auckland, New Zealand, †Department of Nutrition and Dietetics, Auckland City Hospital, Auckland, New Zealand, ‡Department of Critical Care Medicine, Auckland City Hospital, Auckland, New Zealand, §Applied Surgery and Metabolism Laboratory, School of Biological Sciences, University of Auckland, Auckland, New Zealand and ¶Department of General Surgery, Auckland City Hospital, Auckland, New Zealand

doi: 10.1111/ans.17015

Laparoscopy or laparotomy: a snapshot of the Australian approach to surgical repair of perforated gastroduodenal ulcers

Peptic ulcer disease has a 5–10% global lifetime prevalence rate.¹ Perforation of peptic ulcers is the second most common complication, behind bleeding peptic ulcers, but is the most common indication for surgery, accounting for 40% of all ulcer-related deaths.¹ Laparoscopic techniques and surgeon experience in repairing perforated gastroduodenal ulcer (GDU) have improved since first described in the 1980s.² However, there is still variability in the choice of surgical approach. Understanding the factors affecting reasons for and against a surgical approach allows identification of strengths, weaknesses and gaps within current practice to be improved and enhance patient outcomes. This article aims to provide a snapshot of current practice of the Australian general surgeons when choosing between emergency laparoscopy versus laparotomy to repair perforated GDU.

A 24-question survey was created, assessing current practices of general surgeons in Australia, relating to pre-, intra- and post-operative management of patients who have undergone surgical repair of a perforated GDU. Ethical approval to conduct this survey was obtained from the South Metropolitan Health Service Human Research Ethics Committee, Department of Health Western Australia on 10 December 2018, in accordance with the Declaration of Helsinki as revised in Brazil 2013.

Survey questions were approved by the General Surgeons Australia (GSA) Research and Scholarships Subcommittee. General surgical consultants of Australia on the GSA mailing list were invited to the survey which was active for 3 months with a reminder email sent within 1 month of the initial distribution. Descriptive analysis was applied to the survey results. This article will review the experience level of general surgeons who responded to the survey and the range of factors affecting their decision in performing an emergency laparotomy versus laparoscopy.

A total of 100 general surgeons responded of an estimated 700 survey recipients from the GSA. Sixty-nine percent of surgeons had greater than 5 years of experience as a consultant and 98% of general surgeons performed emergency surgical repairs for perforated GDU (Fig. S1).

When surgeons were asked the reasons for their surgical approach, there was greater tendency for laparoscopic approach (42% versus 24% for laparotomy; Table 1) and this preference tended to have a wider distribution of years of experience (Table 2). A greater proportion of surgeons preferring laparotomy had greater than 15 years of experience (Table 2).

Eighty-three percent of surgeons provided at least one factor affecting their decision to start with laparoscopy. Patient physiology, minimal previous abdominal surgery, ulcer characteristics,