5.5a Strategies to Optimize the Delivery of EN: Gastric Residual Volume Threshold

Question: Does the use of higher gastric residual volume (GRV) threshold compared to a lower GRV threshold result in better outcomes in the critically ill adult patient?

Summary of evidence: There was one single centre trial that compared a GRV threshold of 250 mLs to 150 mLs within the context of a feeding protocol and mandatory prokinetics (Pinilla 2001) and one multicentre trial that compared a GRV threshold of 500 mLs to 250 mLs (Montejo 2010). The study by Taylor et al 1999 compared full rate EN with higher GRV thresholds vs gradual start EN with lower GRV thresholds was included in the section 3.2 Target Dose EN. Studies comparing monitoring GRVs to no monitoring are described in section 5.5b Monitoring Gastric Residual Volumes; studies comparing different frequency of monitoring GRVs are included in section 5.5c Frequency of Gastric Residual Volume Monitoring; and those comparing returning or discarding high GRVs are in section 5.5d. Discarding Gastric Residual Volumes.

Mortality: There were no significant difference between the two groups in ICU mortality (RR 1.25, 95% CI 0.78, 2.01, p=0.35) or hospital mortality (RR 1.01, 95% CI 0.74, 1.38, p=0.94) in the study by Montejo et al. Pinilla et al did not report on mortality.

Infections: When the data from both studies was aggregated, there were no significant differences in pneumonia between the groups with higher vs. lower GRV threshold, (RR 1.04, 95% CI 0.73, 1.48, p=0.88, test for heterogeneity I^2 =0%; figure 1).

LOS & ventilator days: There were no differences in ICU length of stay (LOS) between the groups of higher vs. lower GRV thresholds (WMD -0.63, 95% CI -4.88, 3.62, p=0.77, test for heterogeneity I^2 =37%; figure 2). No difference in the duration of ventilation was observed in the only study that reported on this outcome (Montejo 2010, WMD 0.90, 95% CI -2.02, 3.82, p=0.55*).

Other: Pinilla et al (2001) reported a shorter time to reach goal rate of feeding (p<0.09) and a significantly fewer number of patients with high GRV aspirations (p<0.005) in the group with 250 mL vs. 100 mL GRV threshold. In both studies, a significantly higher percentage of nutrition needs/volume was met in the higher GRV threshold group, but the differences would not be considered clinically important. The Pinilla 2001 study reported no differences in overall intolerance between the two groups. In the study by Montejo (2010), the frequency of gastrointestinal complications was significantly lower in the 500mL GRV vs 250 mLs GRV group and this was mainly due to the lower incidence of high GRVs when compared to the lower GRV group. There were no differences between these groups in the number of patients with abdominal distention (Montejo 2010), diarrhea (Pinlla 2001, Montejo 2010), emesis (Pinlla 2001, Montejo 2010), regurgitation or aspiration (Montejo 2010).

Conclusions:
In critically ill patients receiving enteral nutrition, using a higher GRV vs. compared to a lower GRV threshold:

1. Has no effect on mortality, infections or ICU LOS
2. Is not associated with increased gastrointestinal complications
3. Is associated with better nutrition delivery

Level 1 study: *if all of the following are fulfilled: concealed randomization, blinded outcome adjudication and an intention to treat analysis.*
Level 2 study*: If any one of the above characteristics are unfulfilled.*

*p-value calculated from RevMan and differs slightly from that reported in the article.

Table 1. Randomized studies evaluating higher vs. lower gastric residual volumes critically ill patients

Study	Population	Methods (score)	Intervention	Mortality # (%)†	Infections # (%)‡
1) Montejo 2010	Mechanically ventilated patients from 28 ICUs requiring EN for at least 5 days N = 329	C.Random: No ITT: No Blinding: No (5)	GRV limit of 500mL vs. GRV limit of 200mL Both groups: nasogastric EN, prophylactic prokinetics X 3 days & PN, if needed	**GRV 500mL** **GRV 200mL** **ICU** **ICU** 31/157 (20) 26/165 (16) RR 1.25, 95% CI 0.78, 2.01, p=0.35 **Hospital** **Hospital** 53/157 (34) 55/165 (34) RR 1.01, 95% CI 0.74, 1.38, p=0.94	**GRV 500mL** **GRV 200mL** **Pneumonia** 44/157 (28) 45/165 (27)
2) Pinilla 2001	Critically ill patients from a mixed ICU N = 96	C.Random: not sure ITT: yes Blinding: no (9)	Feeding protocol with a higher gastric RV threshold (250 mls) + prokinetics vs feeding protocol with lower GRV (150 mls). Both groups received polymeric formula vis gastric feeds. Non-isocaloric, non-isonitrogenous	NR	**Pneumonia** 1/44 (2) 0/36 (0)

Table 1. Randomized studies evaluating higher vs. lower gastric residual volumes critically ill patients continued)

Study	Length of Stay	Mechanical Ventilation	Other
1) Montejo 2010	**GRV 500mL** **ICU** 20.7 ± 16.2 (157) **GRV 200mL** **ICU** 19.8 ± 15.8 (165)	**GRV 500mL** 15.6 ± 13.6 (157) **GRV 200mL** 14.7 ± 13.1 (165)	**GRV 500ml** **GRV 200mL** **GI Complications** 75/157 (48) 105/165 (64), p=0.004 **High GRV** 42/157 (27) 70/165 (42), p=0.003 **Abdominal distention** 16/157 (10) 18/165 (11), p=0.83 **Diarrhea** 31/157 (20) 33/165 (20), p=0.95 **Emesis** 17/157 (11) 24/165 (15), p=0.31 **Regurgitation** 8/157 (5) 12/165 (7), p=0.41 **Aspiration** 1/157 (1) 0/165 (0). p=0.48 **Mean Diet Volume Ratio in 1st week of EN** 88.2% 84.48%, p=0.0002
	WMD 0.90, 95% CI -2.60, 4.40, p=0.61	WMD 0.90, 95% CI -2.02, 3.82, p=0.55	
2) Pinilla 2001	**ICU** 9.5 ± 6.4 (44) 13.2 ± 18.3 (36)	NR	**Hours to reach goal rate** 15± 10 vs. 22 ± 22; p<0.09 **% nutritional needs met** 76 ± 18 vs.70 ± 25, p<0.2 **Patients with high GRV aspirations** 10/44 (23) vs.19/36 (53); p<0.005 **Patients with intolerance** 20/44 (45) vs. 21/36 (58); p=NS **Patients with emesis** 3/44 (7) vs. 2/36 (6); p=NS **Patients with diarrhea** 10/44 (23) vs. 4/36 (11%); p=NS

C.Random: concealed randomization
† presumed hospital mortality unless otherwise specified
NR: not reported
GRV: gastric residual volume

ITT: intent to treat; NA: not available
± ( ) : mean ± Standard deviation (number)
ICU: intensive care unit

‡ refers to the # of patients with infections unless specified
RR: relative risk; CI: confidence interval
VAP: ventilator associated pneumonia

Figure 1. Pneumonia

Study or Subgroup	Higher GRV Threshold Events	Total	Lower GRV Threshold Events	Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
Pinilla	1	44	0	36	1.2%	2.47 [0.10, 58.78]	2001
Montejo	44	157	45	165	98.8%	1.03 [0.72, 1.46]	2010
Total (95% CI)		**201**		**201**	**100.0%**	**1.04 [0.73, 1.48]**	
Total events	45		45				

Heterogeneity: Tau² = 0.00; Chi² = 0.29, df = 1 (P = 0.59); I² = 0%
Test for overall effect: Z = 0.21 (P = 0.83)

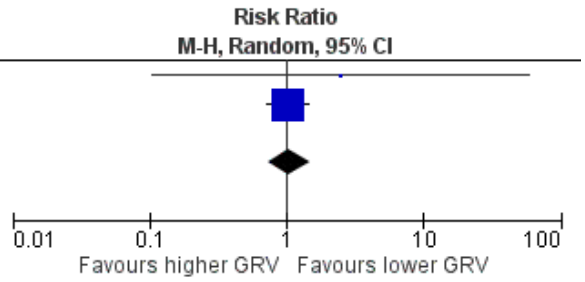
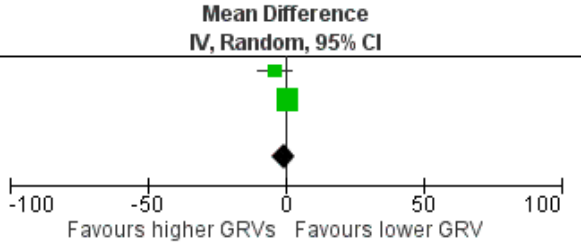


Figure 2. ICU Length of Stay

Study or Subgroup	Higher GRV Threshold Mean	SD	Total	Lower GRV Threshold Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Year
Pinilla	9.5	6.4	44	13.2	18.3	36	33.3%	-3.70 [-9.97, 2.57]	2001
Montejo	20.7	16.2	157	19.8	15.8	165	66.7%	0.90 [-2.60, 4.40]	2010
Total (95% CI)			**201**			**201**	**100.0%**	**-0.63 [-4.88, 3.62]**	

Heterogeneity: Tau² = 3.87; Chi² = 1.58, df = 1 (P = 0.21); I² = 37%
Test for overall effect: Z = 0.29 (P = 0.77)



References

Included Studies

1. Montejo JC, Miñambres E, Bordejé L, Mesejo A, Acosta J, Heras A, Ferré M, Fernandez-Ortega F, Vaquerizo CI, Manzanedo R. Gastric residual volume during enteral nutrition in ICU patients: the REGANE study. Intensive Care Med. 2010 Aug;36(8):1386-93. Epub 2010 Mar 16.

2. Pinilla JC, Samphire J, Arnold C, Liu L, Thiessen B. Comparison of gastrointestinal tolerance to two enteral feeding protocols in critically ill patients: a prospective, randomized controlled trial. JPEN J Parenter Enteral Nutr. 2001;25(2):81-86. doi:10.1177/014860710102500281

Excluded Studies	Reasons
Taylor SJ, Fettes SB, Jewkes C, Nelson RJ. Prospective, randomized, controlled trial to determine the effect of early enhanced enteral nutrition on clinical outcome in mechanically ventilated patients suffering head injury. Crit Care Med. 1999;27(11):2525-2531. doi:10.1097/00003246-199911000-00033	See 3.2: Target Dose EN
McClave SA, Lukan JK, Stefater JA, Lowen CC, Looney SW, Matheson PJ, Gleeson K, Spain DA. Poor validity of residual volumes as a marker for risk of aspiration in critically ill patients. Crit Care Med. 2005 Feb;33(2):324-30.	No clinical outcomes
Juvé-Udina ME, Valls-Miró C, Carreño-Granero A, et al. To return or to discard? Randomised trial on gastric residual volume management. Intensive Crit Care Nurs. 2009;25(5):258-267. doi:10.1016/j.iccn.2009.06.004	See 5.5d: GRV discarding
Poulard F, Dimet J, Martin-Lefevre L, et al. Impact of not measuring residual gastric volume in mechanically ventilated patients receiving early enteral feeding: a prospective before-after study. JPEN J Parenter Enteral Nutr. 2010;34(2):125-130. doi:10.1177/0148607109344745	Not RCT
Kuppinger DD, Rittler P, Hartl WH, Rüttinger D. Use of gastric residual volume to guide enteral nutrition in critically ill patients: a brief systematic review of clinical studies. Nutrition. 2013 Sep;29(9):1075-9.	Systematic review
Reignier J, Mercier E, Le Gouge A, Boulain T, Desachy A, Bellec F, Clavel M, Frat JP, Plantefeve G, Quenot JP, Lascarrou JB; Clinical Research in Intensive Care and Sepsis (CRICS) Group. Effect of not monitoring residual gastric volume on risk of ventilator-associated pneumonia in adults receiving mechanical ventilation and early enteral feeding: a randomized controlled trial. JAMA. 2013 Jan 16;309(3):249-56. doi: 10.1001/jama.2012.196377.	See 5.5b: GRV Monitoring
Williams TA, Leslie G, Mills L, Leen T, Davies H, Hendron D, Dobb GJ. Frequency of Aspirating Gastric Tubes for Patients Receiving Enteral Nutrition in the ICU: A Randomized Controlled Trial. JPEN J Parenter Enteral Nutr. 2014 Sep;38(7):809-16.	See 5.5c: Frequency of GRV monitoring
Chen S, Xian W, Cheng S, et al. Risk of regurgitation and aspiration in patients infused with different volumes of enteral nutrition. Asia Pac J Clin Nutr. 2015;24(2):212-218. doi:10.6133/apjcn.2015.24.2.12	No clinical outcomes
Büyükçoban S, Akan M, Koca U, Eğlen MY, Çiçeklioğlu M, Mavioğlu Ö. Comparison of Two Different Enteral Nutrition Protocol in Critically Ill Patients. Turk J Anaesthesiol Reanim. 2016;44(5):265-269. doi:10.5152/TJAR.2016.92499	See 5.5c: Frequency of GRV monitoring
Ozen N, Tosun N, Yamanel L, Altintas ND, Kilciler G, Ozen V. Evaluation of the effect on patient parameters of not monitoring gastric residual volume in intensive care patients on a mechanical ventilator receiving enteral feeding: A randomized clinical trial. J Crit Care. 2016;33:137-144. doi:10.1016/j.jcrc.2016.01.028	See 5.5b: GRV Monitoring
Tume LN, Bickerdike A, Latten L, et al. Routine gastric residual volume measurement and energy target achievement in the PICU: a comparison study. Eur J Pediatr. 2017;176(12):1637-1644. doi:10.1007/s00431-017-3015-8	Not RCT; Pediatric patients
Pham CH, Collier ZJ, Garner WL, Kuza CM, Gillenwater TJ. Measuring gastric residual volumes in critically ill burn patients - A systematic review. Burns. 2019;45(3):509-525. doi:10.1016/j.burns.2018.05.011	Systematic review
Wang Z, Ding W, Fang Q, Zhang L, Liu X, Tang Z. Effects of not monitoring gastric residual volume in intensive care patients: A meta-analysis. Int J Nurs Stud. 2019;91:86-93. doi:10.1016/j.ijnurstu.2018.11.005	Meta-analysis