5.5 Strategies to Optimize the Delivery of EN: Use of and Threshold for Gastric Residual Volumes

There were no new randomized controlled trials since the 2015 update and hence there are no changes to the following summary of evidence.

Questions:
1. Does the use of higher gastric residual volume threshold (GRVs) result in better outcomes in the critically ill adult patient?
2. Does not checking gastric residual volumes compared to a GRV of 250 mls result in better outcomes in the critically ill adult patient?
3. Does less frequent checking of gastric residual volumes (q 8 hrs) compared to more frequent (q4 hrs) result in better outcomes in the critically ill patient?

Summary of evidence: There was one level 2 multicentre trial that compared a gastric residual volume of 500 mLs to 250 mLs (Montejo 2010). One study compared higher gastric residual volume threshold to lower within the context of a feeding protocol that also included motility agents (Pinilla 2001) and was included in the section 5.1 Feeding Protocols. The study by Taylor et al 1999 compared full rate EN with higher gastric residual volume thresholds vs gradual start EN with lower gastric residual volume thresholds was included in the section 3.2 Target Dose EN. There was a multicenter trial that compared not measuring gastric residual volumes to 250 mLs (Reigner 2013). The trial by Williams et al (2014) compared the frequency of monitoring gastric residual volumes up to every 8 hours vs every 4 hours.

Mortality: In the study by Montejo (2010) 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). There were no differences in 28 day or 90 day mortality between the group that did not check gastric residual volumes vs. the group that checked GRVs > 250 ml in the multicentre study (Reignier 2013). There was also no difference in ICU or hospital mortality between the group with GRVs monitored every 4 hours vs up to every 8 hours (Williams 2014).

Infections: In the study by Montejo (2010), no significant differences were found in pneumonia between the two groups (RR 1.03, 95% CI 0.72, 1.46, p=0.88). There were no significant differences in ICU acquired infections or ventilator associated pneumonia rates between the group that did not check gastric residual volumes vs. the group that did check GRVs in the multicentre study (Reignier 2013). There was also no difference in ventilator associated pneumonia rates between the group with GRVs monitored every 4 hours vs up to every 8 hours (p=0.81, Williams 2014).

LOS & ventilator days: In the study by Montejo (2010), there were no differences in ICU length of stay between the groups (WMD 0.90, 95% CI -2.60, 4.40, p=0.61) and no significant difference in duration of ventilation (WMD 0.90, 95% CI -2.02, 3.82, p=0.55). There were no differences in ICU or hospital length of stay between the group that did not check gastric residual volumes vs. the group that checked GRVs > 250 ml in the multicentre study (Reignier 2013). There was also no difference in ICU length of stay between the group that monitored GRVs every 4 hours vs up to every 8

hours (p=0.57, Williams 2014) but there was a trend towards a reduction in hospital length of stay in the group with gastric residual volumes monitored up to every 8 hours (p=0.19).

Other: 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 (p=0.83), diarrhea (p=0.95), emesis (p=0.31), regurgitation (p=0.41) or aspiration (p=0.48). However, the amount of nutrition delivered in week 1 was significantly higher in the group with the 500ml GRVs threshold (p=0.0002). In the Reignier study, caloric target was achieved in a higher proportion of patients in the group not checking GRVs compared to the groups that did (p<0.001) and there was a lower cumulative calorie deficit from Day 0-7 than this group. There were higher rates of vomiting in the group that did not check gastric residual volumes but no differences in diarrhea. In the Williams (2014) study, there was a significant reduction is vomiting/regurgitation in the group with GRVs monitored every 4 hours (p=0.02) but no difference was found in interruption to EN due to vomiting (p=0.24), or the number of patients who received >80% of goal EN volume (p=0.39). There was a significant reduction in the number of daily tube aspirations in the group in which the GRVs were monitored every 8 hours (p=<0.001).

Conclusions:

1. GRVs of 500 mLs vs 250 mLs have no effect on mortality, infections or ICU LOS
2. Not checking GRVs vs checking GRVs > 250 ml threshold has no effect on mortality, infections, ICU/hospital length of stay
3. Monitoring GRVs every 4 hours vs up to every 8 hours has no effect on mortality, VAP or ICU LOS but may be associated with a reduction in hospital LOS.
4. GRVs of 500 mLs vs 250 mLs are not associated with increased gastrointestinal complications
5. GRVs of 500 mLs vs 250 mLs are associated with better nutrition delivery.
6. Not checking GRVs vs checking GRVs > 250 ml threshold is associated with better caloric delivery.
7. Monitoring GRVs every 4 hours vs up to every 8 hours is associated with a reduction in vomiting/regurgitation but had no effect on 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 gastric residual volume in 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 ICU 31/157 (20) GRV 200mL ICU 26/165 (16) RR 1.25, 95% CI 0.78, 2.01, p=0.35 Hospital 53/157 (34) Hospital 55/165 (34) RR 1.01, 95% CI 0.74, 1.38, p=0.94	GRV 500mL Pneumonia 44/157 (28) GRV 200mL Pneumonia 45/165 (27) RR 1.03, 95% CI 0.72, 1.46, p=0.88
2) Reignier 2013	Mechanically ventilated patients from 9 ICUs requiring EN via NG within 36 hrs after intubation N= 452	C.Random: Yes ITT: Yes Blinding: No (11)	Not monitoring GRV vs. GRV limit of 250 ml Vomiting considered an intolerance to EN in both groups	No GRV ICU 63/227 (28) GRV 250mL ICU 61/222 (28) Hospital 82/227 (36) Hospital 76/222 (34)	No GRV VAP 38/227 (17) GRV 250mL VAP 35/222(16) ICU acquired 60/227 (26) ICU acquired 60/222 (27)
3) Williams 2014	Critically ill pts, single centre, LOS expected >48 hrs, EN expected >72 hrs N=357	C.Random: Yes ITT: Yes Blinding: No (9)	Monitoring GRVs for gastric feeds up to every 8 hrs vs every 4 hrs. For both groups, GRVs were returned if the volume was ≤300 mL and for GRV exceeding 300 mL, the first 300 mL was returned to the stomach and the remainder discarded.	GRVs q8hr ICU 32/178 (18) GRVs q4hr ICU 25/179 (14) Hospital 39/178 (22) Hospital 34/179 (19)	Pts with VAP (p=0.81) 13.2% 14.1%

Table 1. Randomized studies evaluating gastric residual volume in 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) WMD 0.90, 95% CI -2.60, 4.40, p=0.61	GRV 500mL 15.6 ± 13.6 (157) GRV 200mL 14.7 ± 13.1 (165) WMD 0.90, 95% CI -2.02, 3.82, p=0.55	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
2) Reignier 2013	No GRV GRV 250mL ICU 10 (6-17) 10 (7-17) Hospital 17 (9-31) 19 (10-32)	No GRV 7 (4-13) GRV 250mL 7 (5-13)	No GRV GRV 250mL Vomiting 90/227 (40) 60/222 (27) Diarrhea 51/227 (23) 51/222 (23) EN intolerance 90/227 (40) 141/222 (64)
3) Williams 2014	GRVs q8hr GRVs q4hr ICU 9 (6-14) 9 (5-15) Hospital 23 (12-38) 25 (13-41)	NR	GRVs q8hr GRVs q4hr Vomiting/regurgitation (p=0.02) 3.6% 2.1% EN interruption due to vomiting (p=0.24) 2.1% 1.5% Tube aspirations per day (p=<0.001) 3.4 (1.3) 5.4 (1.3) ≥80% EN volume received (p=0.39) 50% of pts 48% of pts

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

Table 2. Excluded Articles

#	Reason excluded	Citation
1	No clinical outcomes	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.
2	Systematic review	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.
3	No clinical outcomes	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 Jun;33:137-44.